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ENGINE MECHANICAL

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SERVICE INFORMATION

PRECAUTIONS

Precaution for Supplemental Restraint System (SRS) "AIR BAG" and "SEAT BELT PRE-TENSIONER"

INFOID:0000000006927439

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. Information necessary to service the system safely is included in the SRS and SB section of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the SRS section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

PRECAUTIONS WHEN USING POWER TOOLS (AIR OR ELECTRIC) AND HAMMERS

WARNING:

- **When working near the Airbag Diagnosis Sensor Unit or other Airbag System sensors with the Ignition ON or engine running, DO NOT use air or electric power tools or strike near the sensor(s) with a hammer. Heavy vibration could activate the sensor(s) and deploy the air bag(s), possibly causing serious injury.**
- **When using air or electric power tools or hammers, always switch the Ignition OFF, disconnect the battery, and wait at least 3 minutes before performing any service.**

Precaution for Draining Engine Coolant

INFOID:0000000006927440

Drain engine coolant when engine is cooled.

Precaution for Disconnecting Fuel Piping

INFOID:0000000006927441

- Before starting work, make sure no fire or spark producing items are in the work area.
- After disconnecting pipes, plug openings to stop fuel leakage.

Precaution for Removal and Disassembly

INFOID:0000000006927442

- When instructed to use SST, use the specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Cover openings of engine system with tape or the equivalent, if necessary, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and re-assembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified.

Precaution for Inspection, Repair and Replacement

INFOID:0000000006927443

Before repairing or replacing, thoroughly inspect parts. Inspect new replacement parts in the same way, and replace if necessary.

Precaution for Assembly and Installation

INFOID:0000000006927444

- Use torque wrench to tighten bolts or nuts to specification.
- When tightening nuts and bolts, as a basic rule, equally tighten in several different steps starting with the ones in center, then ones on inside and outside diagonally in this order. If the order of tightening is specified, do exactly as specified.
- Replace with new liquid gasket, packing, oil seal or O-ring.

- Dowel pins are used for several parts alignment. When replacing and reassembling parts with dowel pins, make sure that dowel pins are installed in the original position.
- Thoroughly wash, clean, and air-blow each part. Carefully check engine oil or engine coolant passages for any restriction and blockage.
- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- Release air within route when refilling after draining engine coolant.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust systems for leakage.

Parts Requiring Angular Tightening

INFOID:0000000006927445

- Use an angle wrench for the final tightening of the following engine parts:
- Cylinder head bolts
- Connecting rod cap nuts
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precaution for Liquid Gasket

INFOID:0000000006927446

REMOVAL OF LIQUID GASKET SEALING

- After removing the bolts and nuts, disconnect the component using a seal cutter.

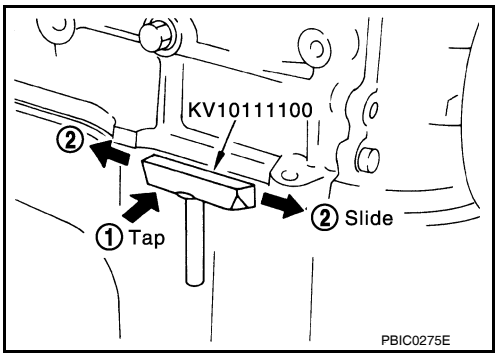
CAUTION:

Be careful not to damage the mating surfaces.

- Use a plastic hammer to lightly tap (1) the areas where the liquid gasket is applied. To advance the cutter, use a plastic hammer to slide (2) the cutter along the joint.

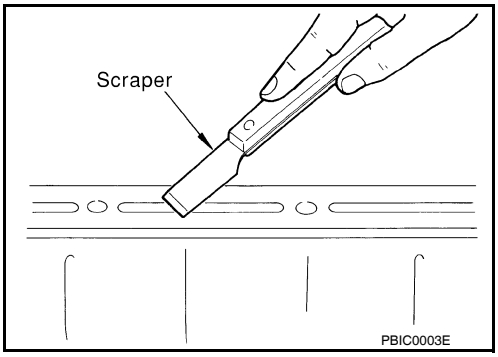
CAUTION:

If for some unavoidable reason a tool such as a flat-bladed screwdriver is used, be careful not to damage the mating surfaces.

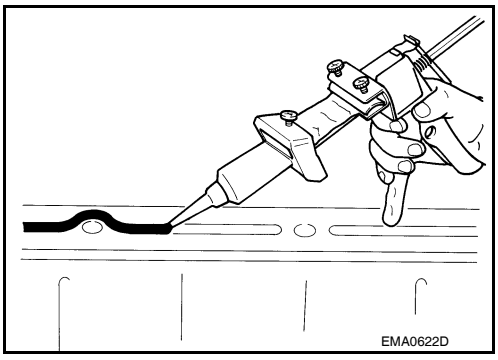


LIQUID GASKET APPLICATION PROCEDURE

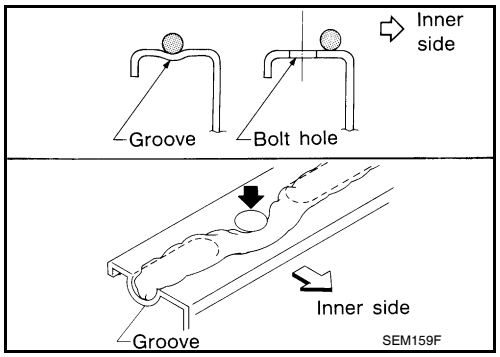
1. Using a scraper, remove the old liquid gasket adhering to the gasket application surface and the mating surface.
   - Remove the sealant completely from the groove of the gasket application surface, bolts, and bolt holes.



2. Thoroughly clean the gasket application surface and the mating surface and remove adhering moisture, grease and foreign materials.
3. Attach the sealant tube to the tube presser.



4. Apply the sealant without breaks to the specified location with the specified dimensions.
   - If there is a groove for the sealant application, apply the sealant to the groove.
   - As for the bolt holes, normally apply the sealant inside the holes. If specified, it should be applied outside the holes. Make sure to read the text of this manual.
   - Within five minutes of the sealant application install the mating component.
   - If the sealant protrudes, wipe it off immediately.
   - Do not retighten after the installation.
   - After 30 minutes or more have passed from the installation, fill the engine with the specified oil and coolant. Refer to LU-7, "Changing Engine Oil" and CO-10, "Changing Engine Coolant".

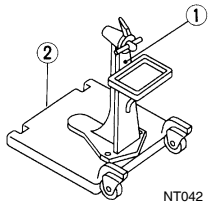
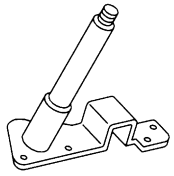
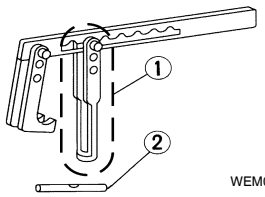
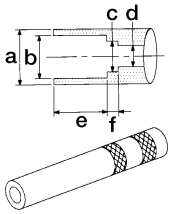
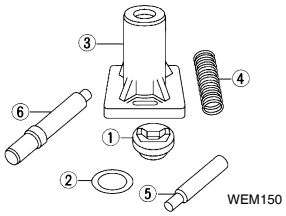


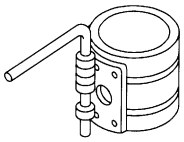
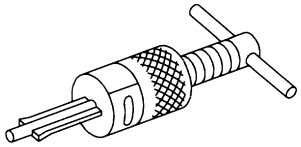
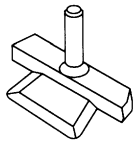
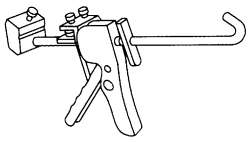
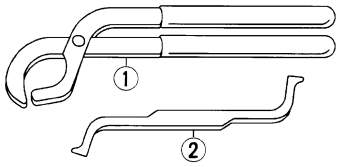
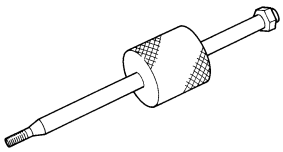
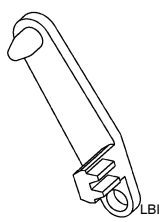
PREPARATION

Special Service Tool

INFOID:0000000006927447

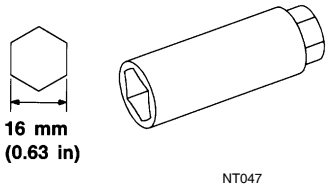
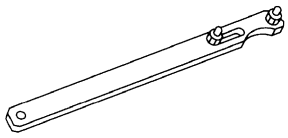
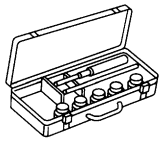
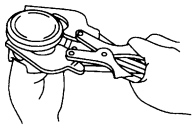
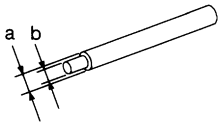
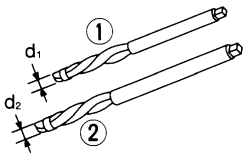
The actual shapes of Kent-Moore tools may differ from those of the special service tools illustrated here.

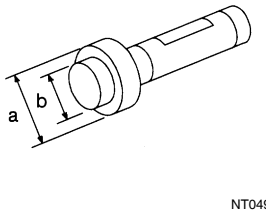
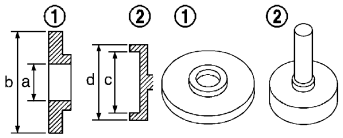
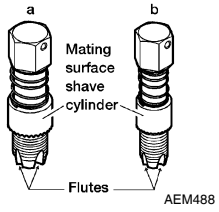
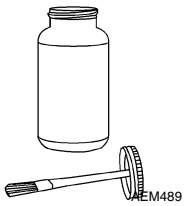
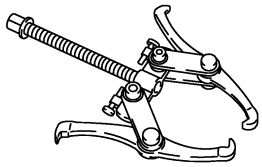
Tool number (Kent-Moore No.) Tool name	Description
ST0501S000 (—) Engine stand assembly **1** ST05011000 (—) Engine stand **2** ST05012000 (—) Base  NT042	Disassembling and assembling
KV10105001 (—) Engine attachment  NT031	
KV101092S0 (J26336-B) Valve spring compressor **1** KV10109210 (—) Compressor **2** KV100109220 (—) Adapter  WEM044	Disassembling and assembling valve components
KV10116300 (J-38955) Valve oil seal drift  WEM151	Installing valve oil seal **a: 25 (0.98) dia.** **b: 14.4 (0.567) dia.** **c: 11.8 (0.465) dia.** **d: 10 (0.39) dia.** **e: 11 (0.43)** **f: 9 (0.35)**
KV10110300 (—) Piston pin press stand assembly **1** KV10110310 (—) Cap **2** KV10110330 (—) Spacer **3** ST13030020 (—) Press stand **4** ST13030030 (—) Spring **5** KV10110340 (—) Drift **6** KV10110320 (—) Center shaft  WEM150	Disassembling and assembling piston with connecting rod

Tool number (Kent-Moore No.) Tool name	Description
EM03470000 (J-8037) Piston ring compressor  NT044	Installing piston assembly into cylinder bore
ST16610001 (J-23907) Pilot bushing puller  NT045	Removing crankshaft pilot bushing
KV10111100 (J-37228) Seal cutter  NT046	Removing oil pan
WS39930000 (—) Tube presser  NT052	Pressing the tube of liquid gasket
KV101151S0 (J-38972) Lifter stopper set **1** KV10115110 (J-38972-1) Camshaft pliers **2** KV10115120 (J-38972-2) Lifter stopper  S-NT041	Changing valve lifter shims
KV10114700 (J-38139) Main bearing cap remover  ZZA0023D	Removing crankshaft main bearing cap **For No. 3 and No. 5 bearings**
— (J-45499) Ring gear stopper  LBIA0362E	Preventing crankshaft rotation

Commercial Service Tool

INFOID:0000000006927448

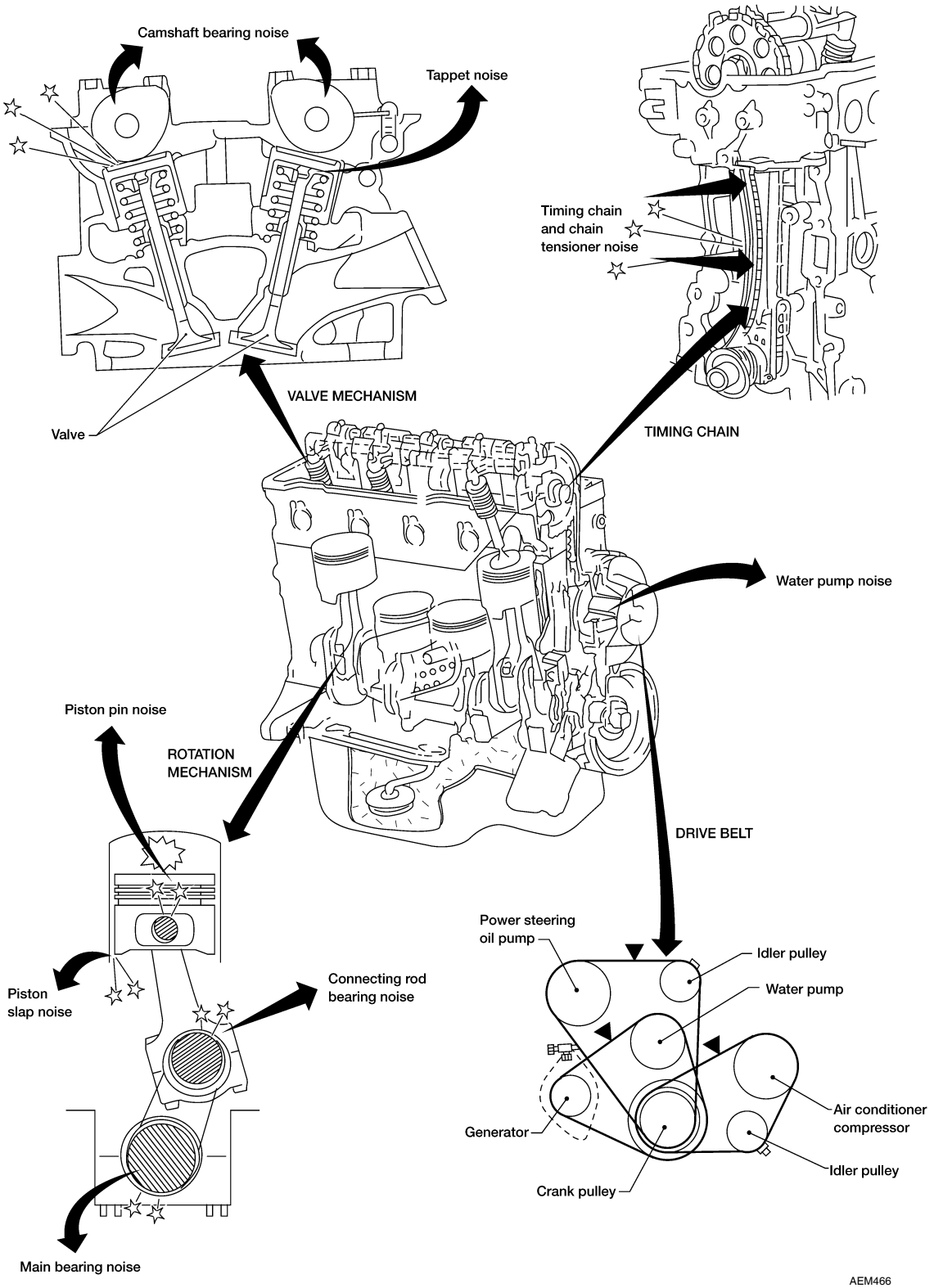
Tool name (Kent-Moore No.)	Description
Spark plug wrench  NT047	Removing and installing spark plug
Pulley holder  NT035	Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set  NT048	Finishing valve seat dimensions
Piston ring expander  NT030	Removing and installing piston ring
Valve guide drift  NT015	Removing and installing valve guide **Intake & Exhaust:** **a = 10.5 mm (0.413 in) dia.** **b = 6.6 mm (0.260 in) dia.**
Valve guide reamer  NT016	Reaming valve guide 1 or hole for oversize valve guide 2 **Intake:** **d_1 = 7.0 mm (0.276 in) dia.** **d_2 = 11.2 mm (0.441 in) dia.** **Exhaust:** **d_1 = 8.0 mm (0.315 in) dia.** **d_2 = 12.2 mm (0.480 in) dia.**

Tool name (Kent-Moore No.)	Description
Front oil seal drift  NT049	Installing front oil seal **a: 52 mm (2.05 in) dia.** **b: 44 mm (1.73 in) dia.**
Rear oil seal drift  WEM152	Installing rear oil seal **a: 46 mm (1.81 in)** **b: 110 mm (4.33 in)** **c: 84 mm (3.31 in)** **d: 96 mm (3.78 in)**
Thread repair tool for oxygen sensor a: (J-43897-18) b: (J-43897-12)  AEM488	**a: 18 mm (0.71 in)** **b: 12 mm (0.47 in)**
Anti-seize thread compound  AEM489	For preventing corrosion, seizing, and galling on high temperature applications.
Crankshaft pulley puller  PBIC0887E	Removing crankshaft pulley

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

Noise, Vibration and Harshness (NVH)

INFOID:0000000006927449



NVH TROUBLESHOOTING CHART — ENGINE NOISE

Use the chart below to help you find the cause of the symptom.

1. Locate the area where noise occurs.
2. Confirm the type of noise.

3. Specify the operating condition of the engine.
4. Check the specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When revving	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-39
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-39
Crankshaft pulley Cylinder block (upper side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-55, or EM-55
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston ring side clearance Piston ring end gap Connecting rod bend and torsion Piston-to-bore clearance	EM-55, EM-55, EM-55, or EM-55
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bearing clearance (Big end) Connecting rod bushing clearance (Small end)	EM-55, or EM-55
	Knock	A	B	—	A	B	C	Main bearing noise	Crankshaft runout Main bearing oil clearance	EM-55, or EM-55
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear	EM-29
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belt deflection	EM-15
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-18, "Inspection"

A: Closely related B: Related C: Sometimes related —: Not related:

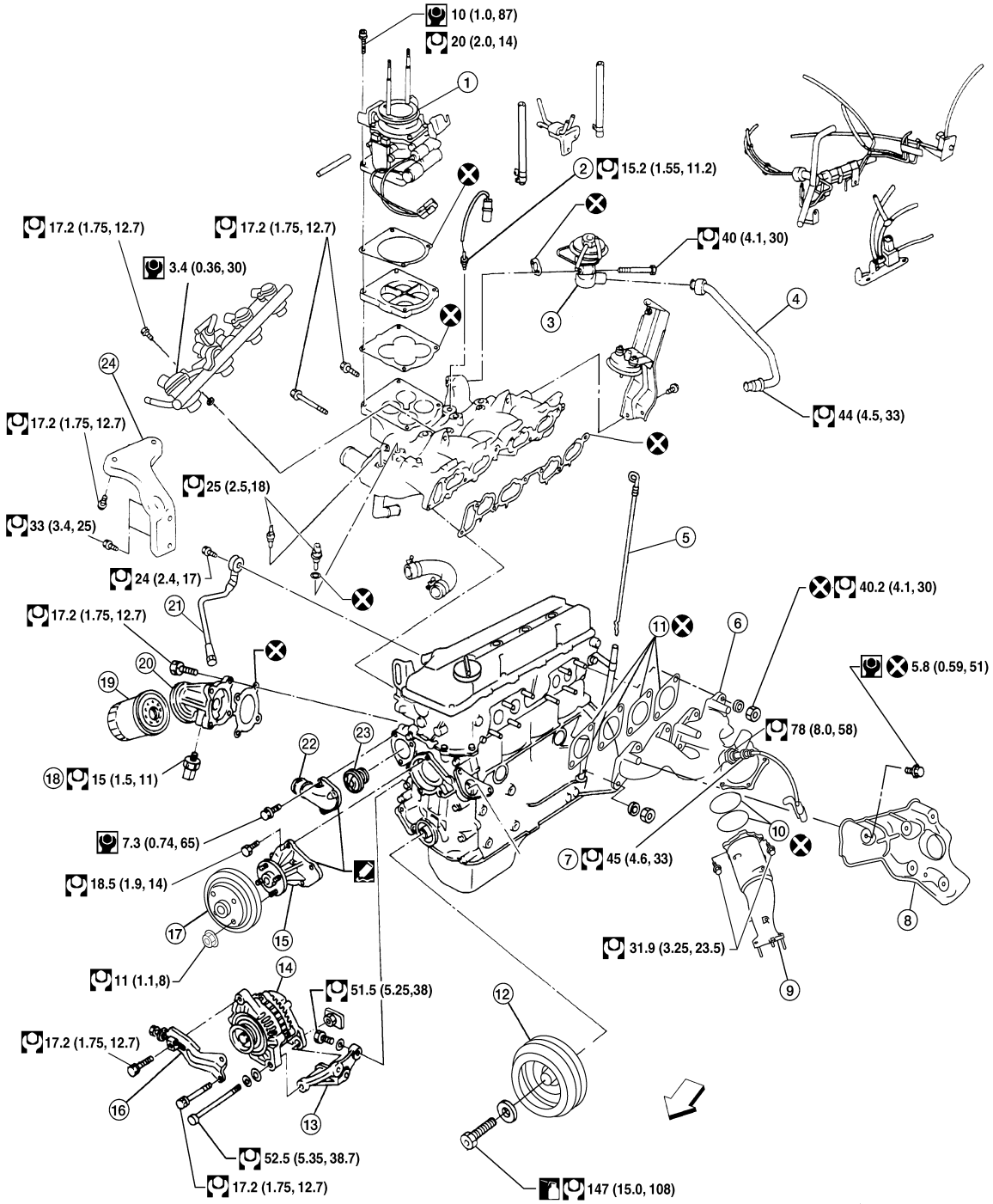
OUTER COMPONENT PARTS

Removal and Installation

INFOID:0000000006927450

Engine Outer Components

SEC. 120 • 140 • 147 • 150 • 163 • 164 • 210 • 220 • 221 • 230 • 231



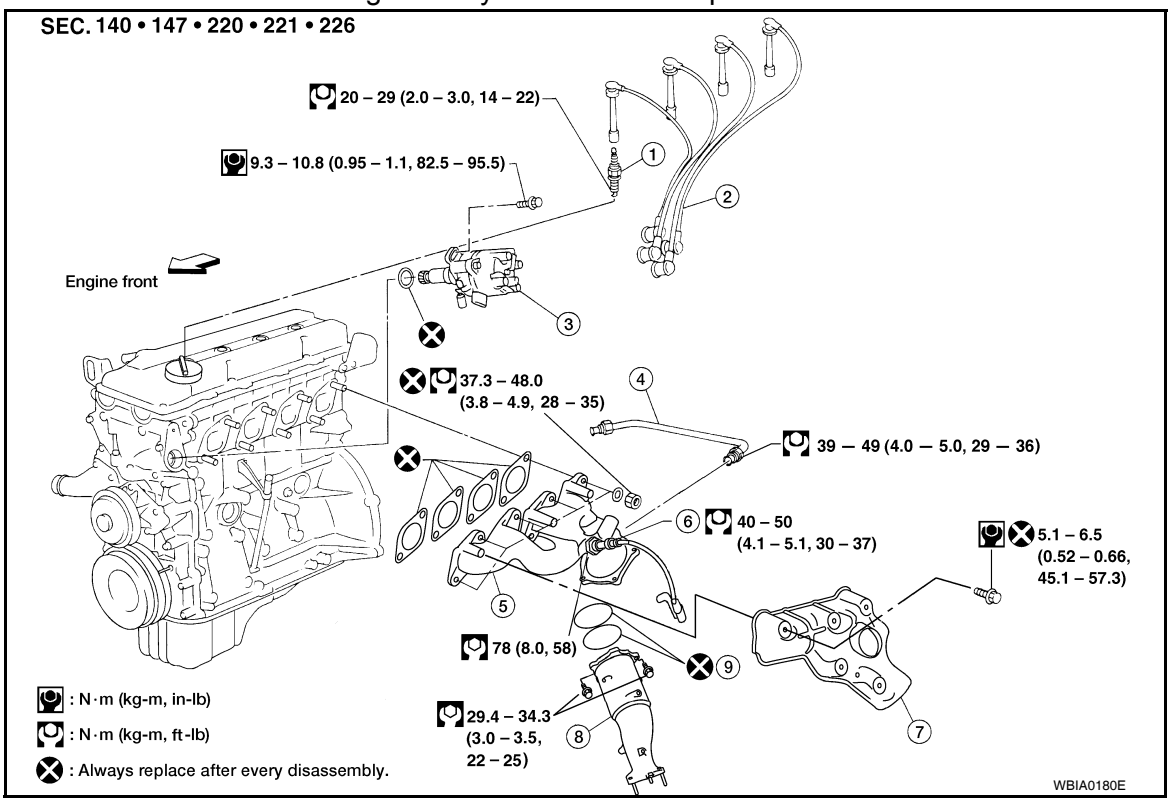
AWBIA0616GB

1. Throttle body
2. EGR temperature sensor (if equipped)
3. EGR valve (if equipped)
4. EGR tube (if equipped)
5. Oil dipstick
6. Exhaust manifold
7. Heated oxygen sensor 1
8. Exhaust manifold cover
9. TWC (manifold)

10. TWC (manifold) gaskets
11. Exhaust manifold gaskets
12. Crankshaft pulley
13. Generator bracket
14. Generator
15. Water pump
16. Adjusting bar
17. Water pump pulley
18. Oil pressure switch
19. Oil filter
20. Oil filter bracket
21. Knock sensor
22. Water inlet
23. Thermostat
24. Intake manifold bracket

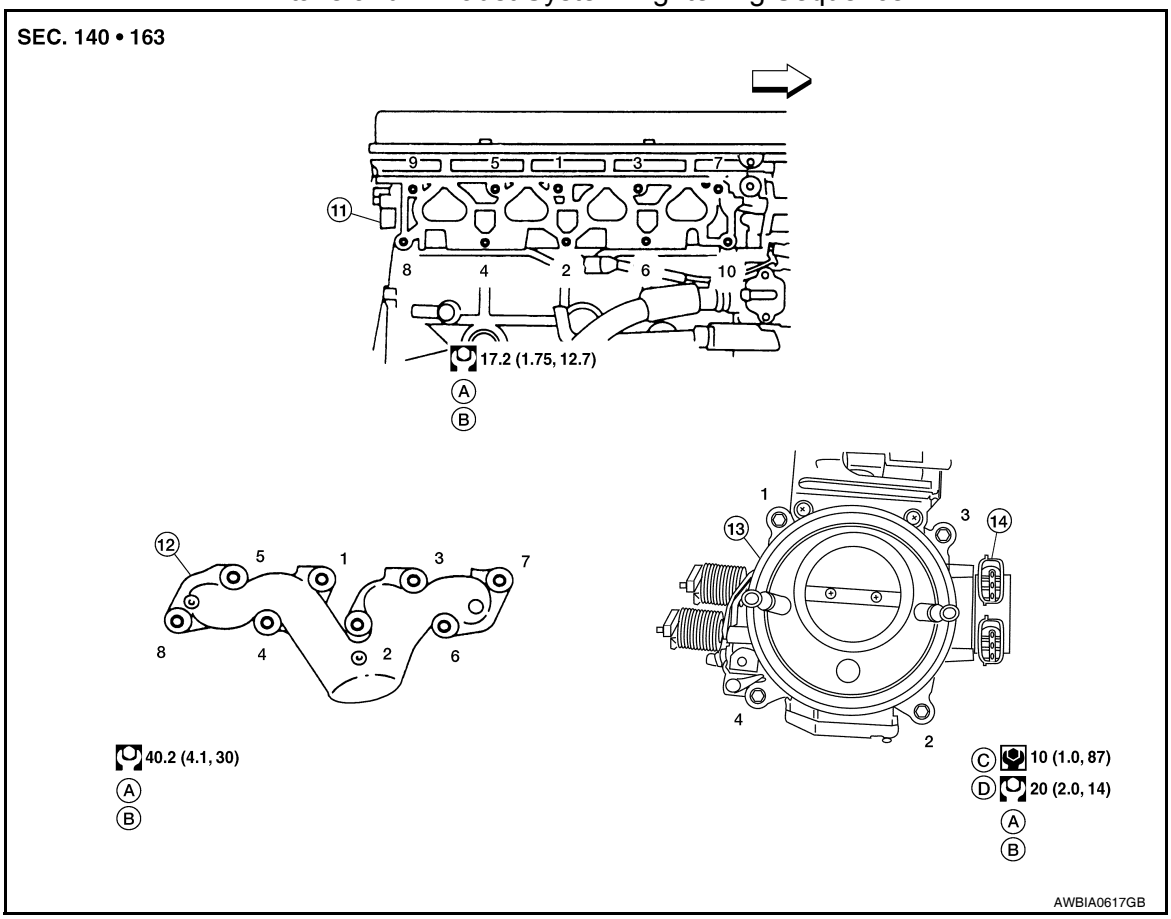
⇦ Front

Ignition System Outer Components



1. Spark plug
2. Ignition wires
3. Camshaft position sensor built into distributor
4. EGR tube (if equipped)
5. Exhaust manifold
6. Heated oxygen sensor 1
7. Exhaust manifold cover
8. TWC (manifold)
9. TWC (manifold) gaskets

Intake and Exhaust System Tightening Sequence

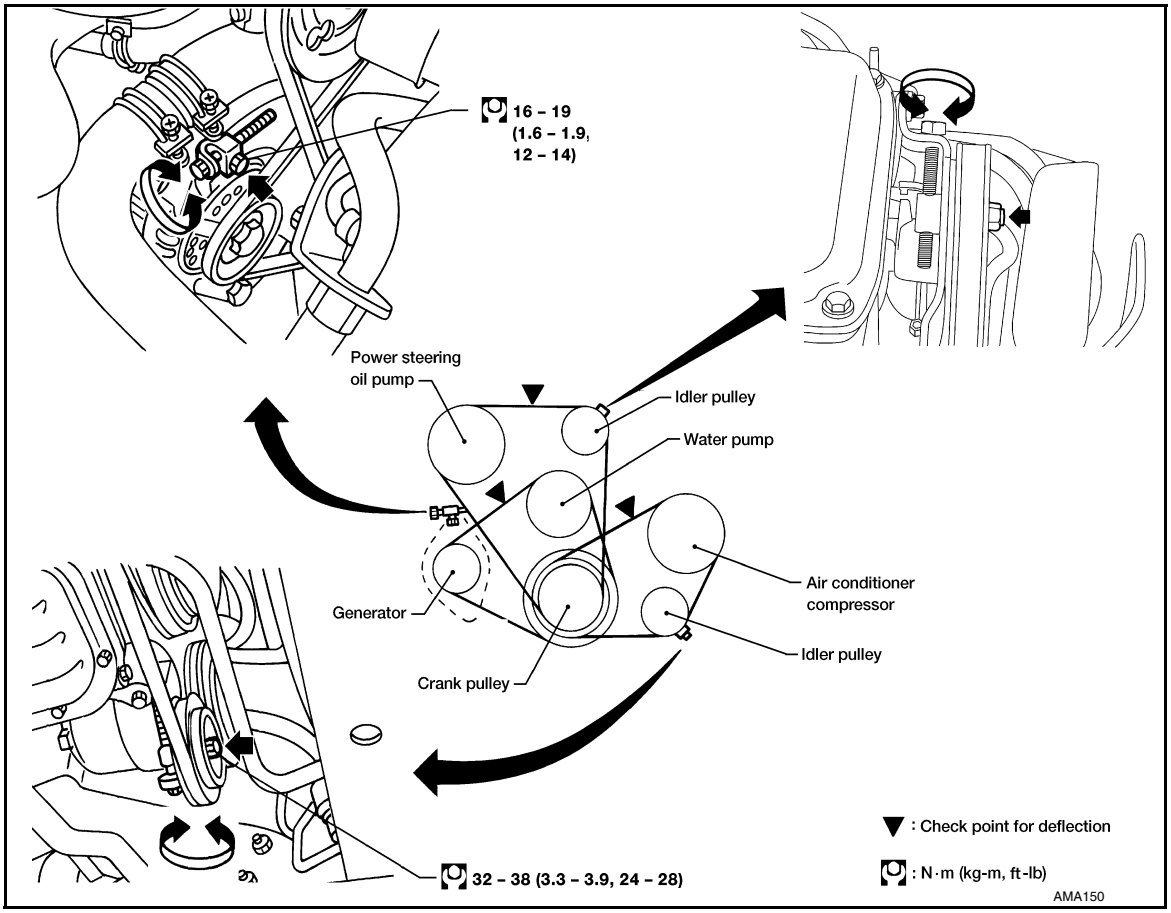


1. - 10. Tightening sequence
11. Intake manifold
12. Exhaust manifold
13. Throttle body
14. Throttle position sensor
A. Tighten in numerical order
B. Loosen in reverse order
C. 1st
D. 2nd
⇦ Front

DRIVE BELTS

Checking Drive Belts

INFOID:0000000006927451



1. Inspect belt for cracks, fraying, wear and oil. If necessary, replace.
2. Inspect drive belt deflection or tension at a point on the belt midway between pulleys using Tool.

Tool number : BT-3373-F

NOTE:
- Inspect drive belt deflection or tension when engine is cold.
- Adjust if belt deflections exceed the limit or if belt tension is not within specifications.
- Drive belt tension can be checked at other points on the belt, if necessary.

DRIVE BELT DEFLECTION AND TENSION

	Deflection adjustment Unit: mm (in)			Tension adjustment *1 Unit: N (kg, lb)		
	Used belt		New belt	Used belt		New belt
	Limit	After adjustment		Limit	After adjustment	
Generator	17 (0.67)	10 - 12 (0.39 - 0.47)	8 - 10 (0.31 - 0.39)	222.4 (22.7, 50)	355.8 - 444.8 (36.3 - 45.4, 80 - 100)	489.3 - 578.2 (49.9 - 59.0, 110 - 130)
Air conditioner compressor	16 (0.63)	10 - 12 (0.39 - 0.47)	8 - 10 (0.31 - 0.39)	200.2 (20.4, 45)	355.8 - 444.8 (36.3 - 45.4, 80 - 100)	489.3 - 578.2 (49.9 - 59.0, 110 - 130)
Power steering oil pump	17 (0.67)	10 - 13 (0.39 - 0.51)	8 - 10 (0.31 - 0.39)	222.4 (22.7, 50)	355.8 - 444.8 (36.3 - 45.4, 80 - 100)	489.3 - 578.2 (49.9 - 59.0, 110 - 130)
Applied pushing force	98 N (10 kg, 22 lb)			—		

*1: If belt tension gauge cannot be installed at check point shown, check belt tension at a different location on the belt.

Removal and Installation

INFOID:0000000006927452

REMOVAL

1. Loosen generator adjusting bar and release belt tension on generator belt. Refer to EM-12, "Removal and Installation".
2. Loosen idler pulley and release belt tension on power steering belt, if equipped. Refer to EM-15, "Checking Drive Belts".
3. Loosen idler pulley and release belt tension on A/C compressor belt, if equipped. Refer to EM-15, "Checking Drive Belts".
4. Remove belts as necessary.

INSTALLATION

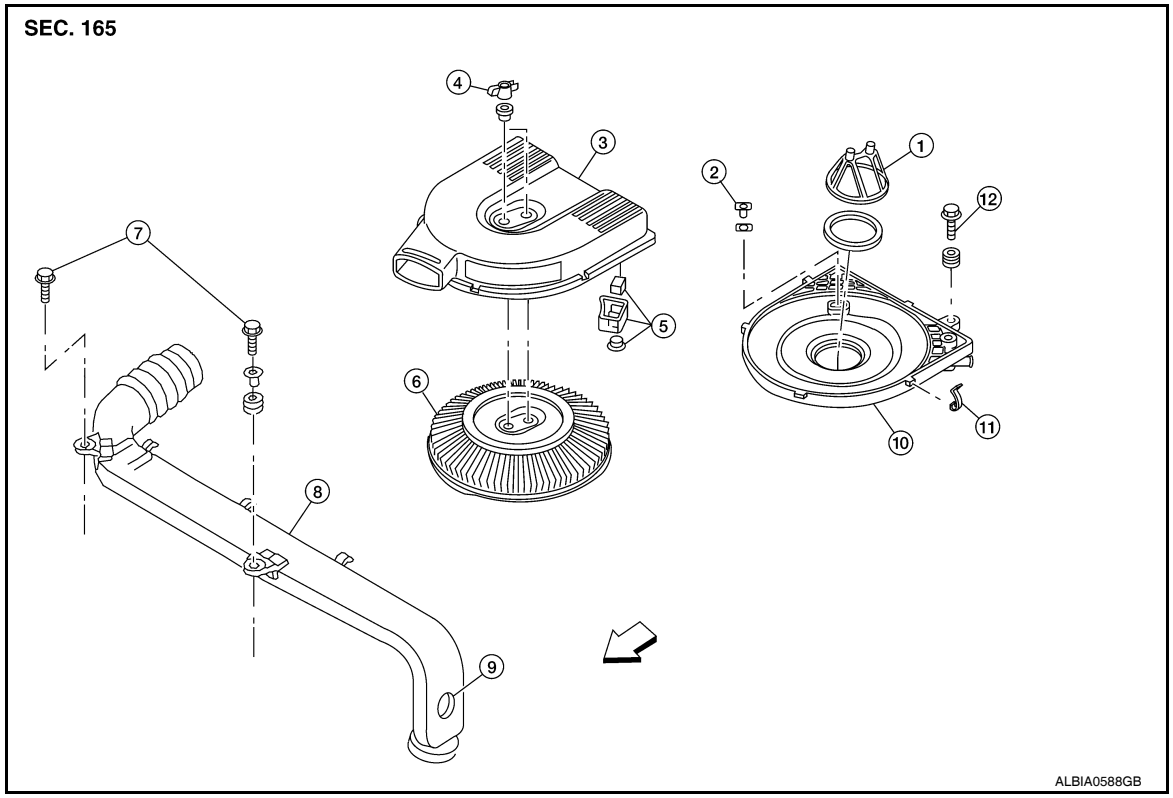
Installation is in the reverse order of removal.

- Adjust drive belt deflection and tension to specification. Refer to EM-15, "Checking Drive Belts".

AIR CLEANER AND AIR DUCT

Component

INFOID:0000000006927453



1. Air cleaner assembly support
2. Drain tube
3. Air cleaner case (upper)
4. Wing nut
5. PCV valve
6. Air cleaner filter
7. Air duct bolts
8. Air duct
9. Intake air temperature sensor
10. Air cleaner case (lower)
11. Clip
12. Air cleaner case bolt (lower)

⇦ Front

Removal and Installation

INFOID:0000000006927454

REMOVAL

1. Disconnect intake air temperature sensor harness connector.
2. Disconnect vacuum hoses from air duct.
3. Remove air duct bolts and air duct.
4. Remove air cleaner case bolt (lower).
5. Disconnect PCV hose from air cleaner case (lower).
6. Remove wing nuts and air cleaner assembly.

INSTALLATION

Installation is in the reverse order of removal.

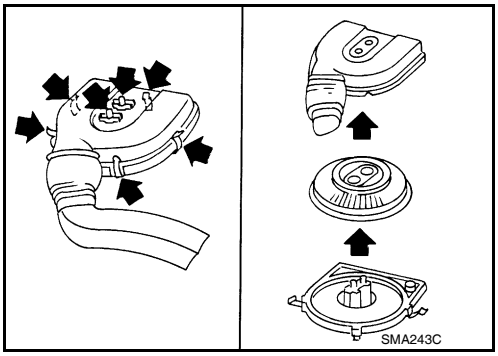
CAUTION:

If intake air temperature sensor is dropped, do not reuse it.

CHANGING AIR CLEANER FILTER

Removal

1. Remove wing nuts.
2. Disconnect air duct from air cleaner case (upper).
3. Disconnect clips from air cleaner case (upper) and remove air cleaner case (upper).
4. Remove air cleaner filter.



Installation
Installation is in the reverse order of removal.

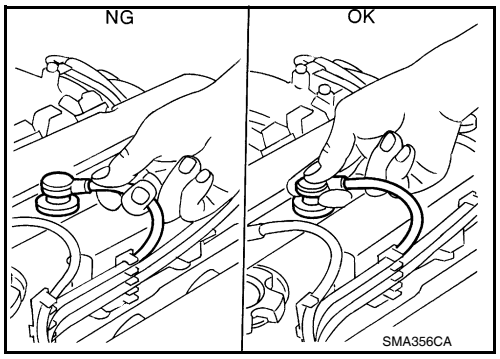
SPARK PLUG

Removal and Installation

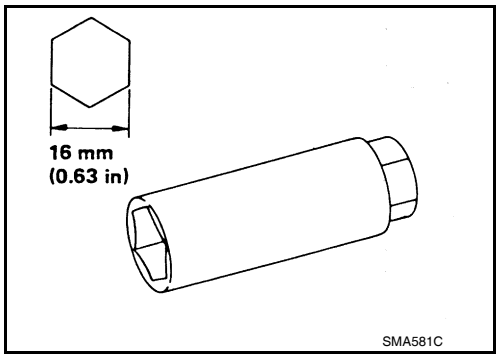
INFOID:0000000006927455

REMOVAL

1. Disconnect ignition wires from spark plugs at boot.
   CAUTION:
   Do not pull on the wire.



2. Remove spark plugs with spark plug wrench.



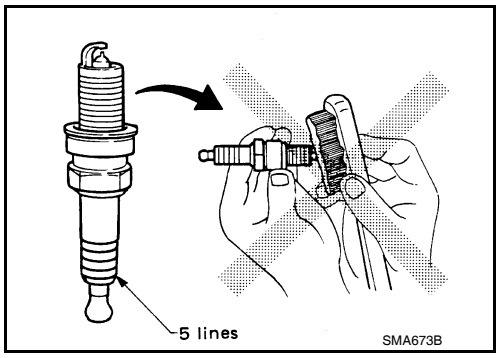
Spark Plug

Make	NGK
Standard type	BKR5E-11

Use standard type spark plug under normal conditions.
- Do not use a wire brush for cleaning.
- If plug tip is covered with carbon, spark plug cleaner may be used.

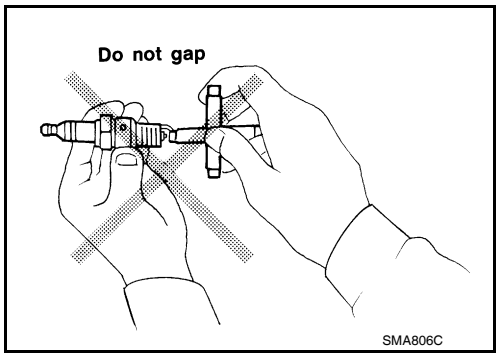
Cleaner air pressure **: Less than 588 kPa (6 kg/cm^2, 85 psi)**

Cleaning time **: Less than 20 seconds**



- Checking and adjusting plug gap is not required between change intervals.

Spark plug gap (nominal) **: 1.1 mm (0.043 in)**



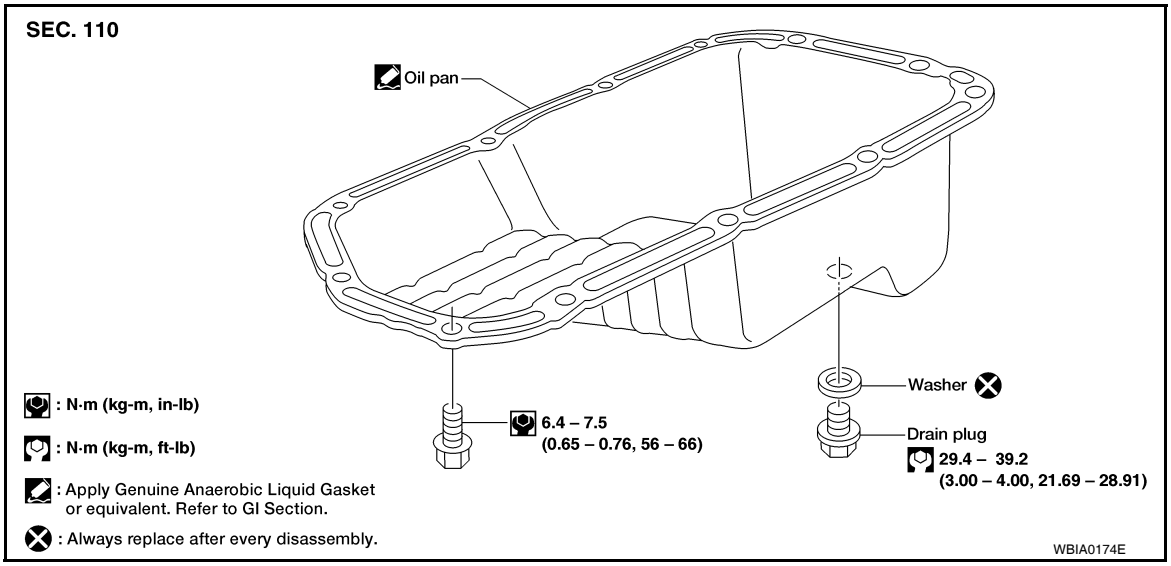
INSTALLATION

Installation is in the reverse order of removal.

OIL PAN

Component

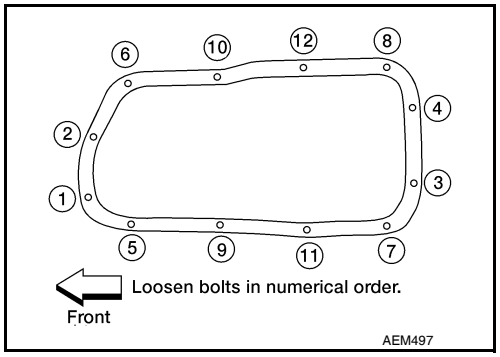
INFOID:0000000006927456



Removal

INFOID:0000000006927457

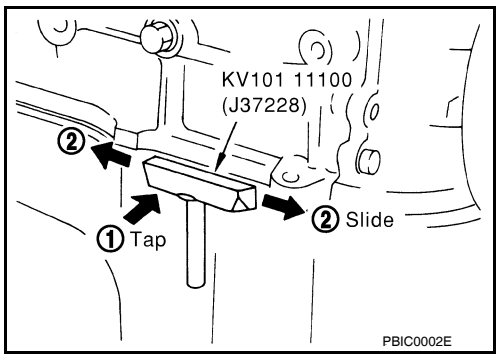
1. Remove the engine under cover.
2. Drain the engine oil. Refer to LU-7, "Changing Engine Oil".
3. Remove the front suspension cross member.
4. Remove the oil pan bolts in the numerical order as shown.



5. Remove the oil pan using Tool as shown.

a. Insert Tool between the cylinder block and oil pan, and separate the oil pan from the engine block by tapping (1) with a plastic hammer as shown.
   - Be careful not to damage the aluminum mating surface.
   - Do not insert a screwdriver, which may damage the oil pan flange.

b. Slide (2) the Tool by tapping on the side of the Tool with a plastic hammer as shown.

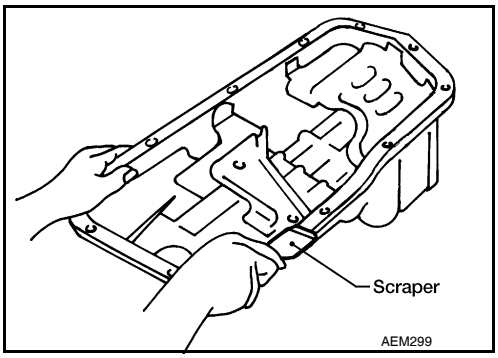


6. Pull the oil pan out from the front side.

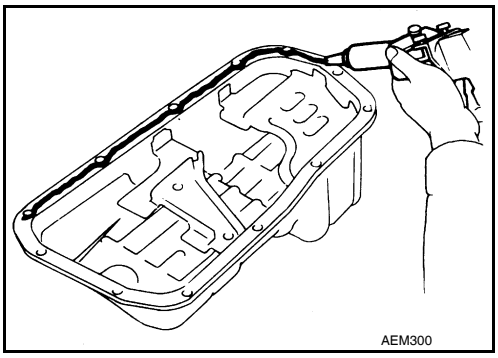
Installation

INFOID:0000000006927458

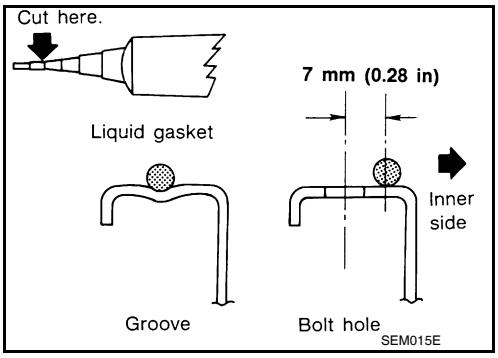
1. Use a scraper to remove the old liquid gasket from the mating surface of the oil pan.
   - Remove all traces of the liquid gasket from the mating surface of the cylinder block.



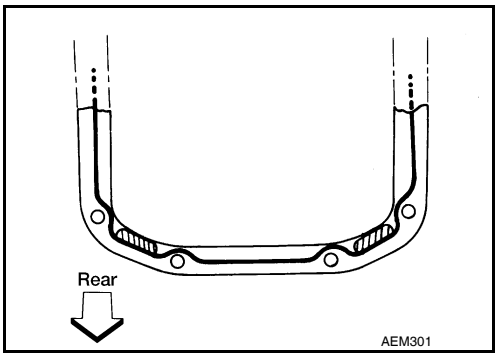
2. Apply a continuous bead of liquid gasket to the mating surface of the oil pan.
   - Use Genuine Anaerobic Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".
   - Apply the liquid gasket to the groove on the oil pan mating surface.



   - Allow a 7 mm (0.28 in) clearance around the bolt holes.

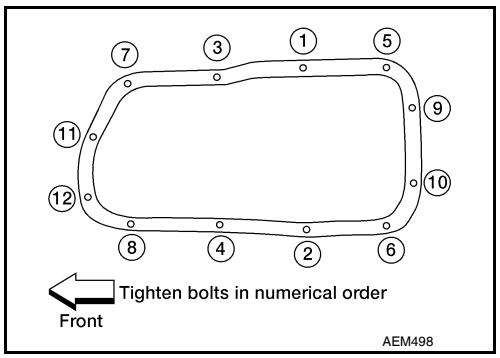


   - Be sure the bead of liquid gasket has a diameter of 3.5 - 4.5 mm (0.138 - 0.177 in).
   - Installation must be done within 5 minutes after applying the liquid gasket.



3. Install the oil pan.
   - Wait at least 30 minutes before refilling the engine oil.
   - Tighten the oil pan bolts to specification in numerical order as shown.

Oil pan bolts **: 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 56 - 66 in-lb)**

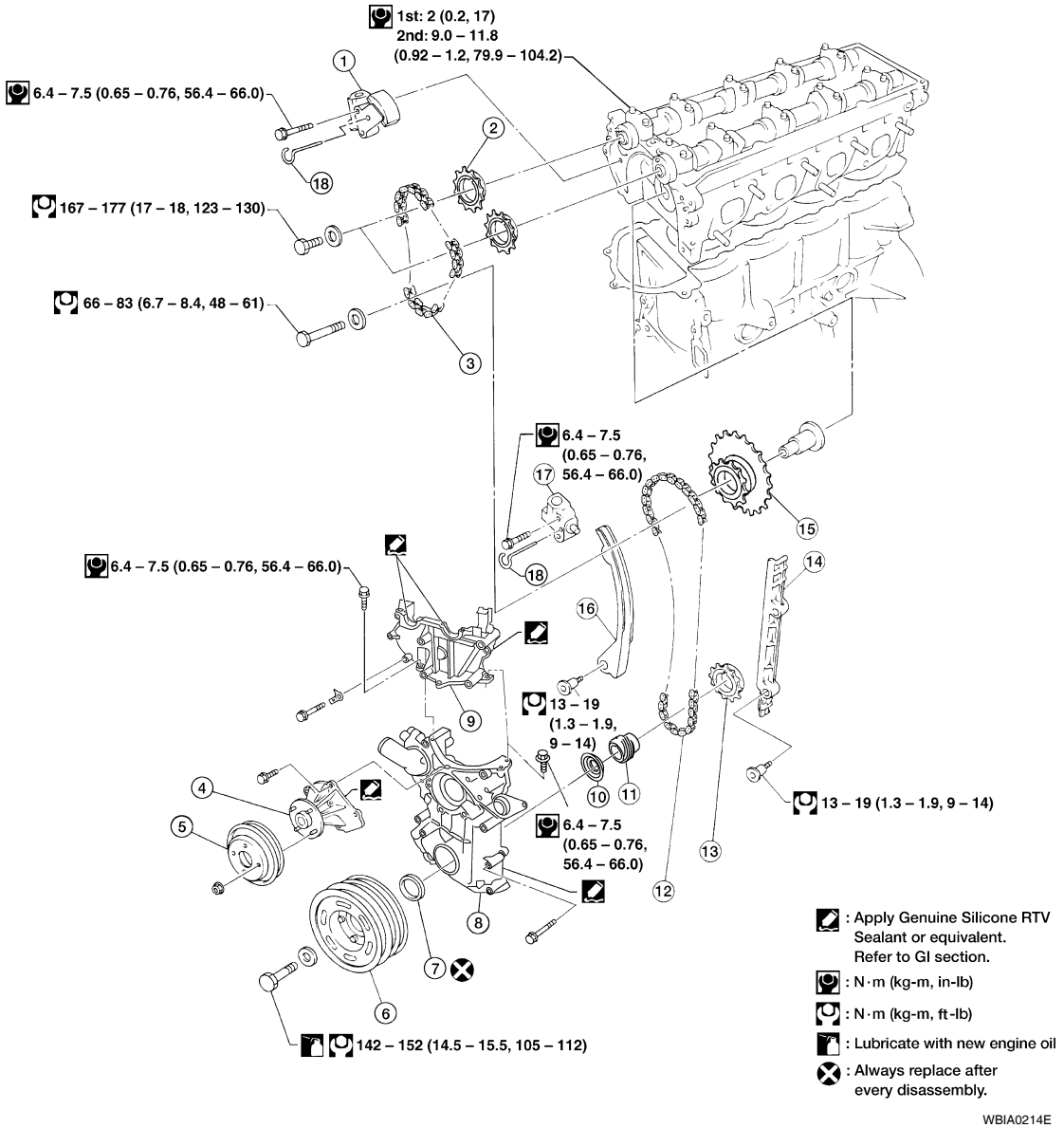


4. Install the remaining parts in the reverse order of removal.

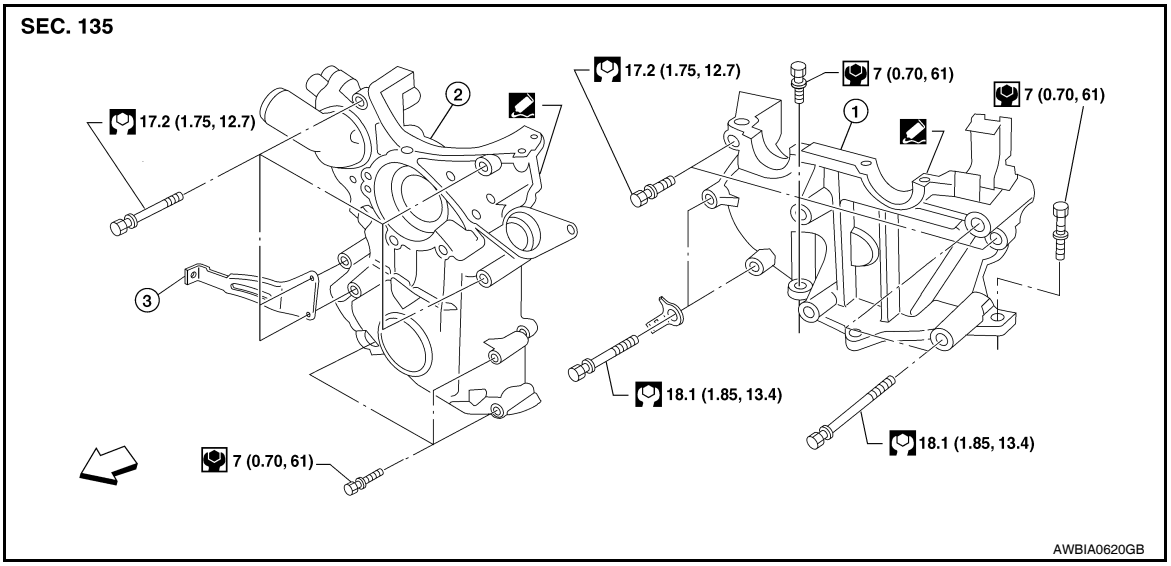
TIMING CHAIN

Component

INFOID:0000000006927459



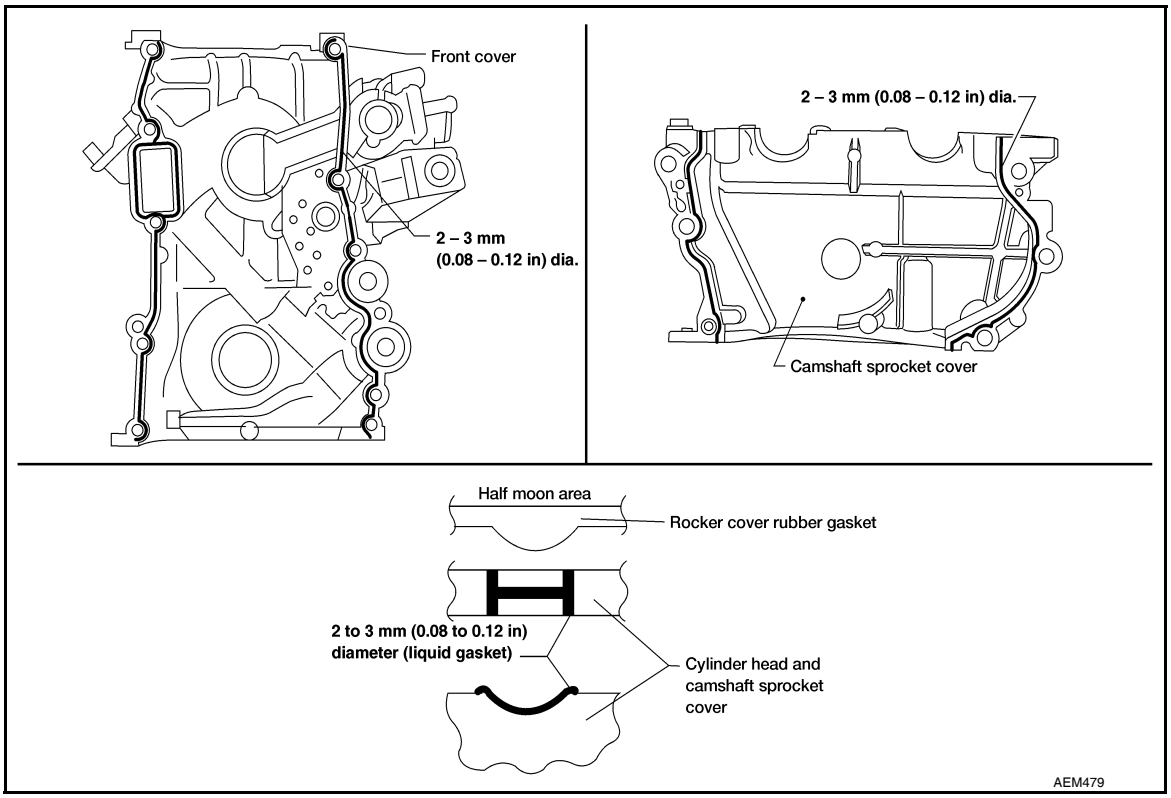
1. Timing chain tensioner (upper)
2. Cam sprocket
3. Timing chain (upper)
4. Water pump
5. Water pump pulley
6. Crankshaft pulley
7. Front oil seal
8. Front cover
9. Camshaft sprocket cover
10. Oil slinger
11. Oil pump drive gear
12. Timing chain (lower)
13. Crankshaft sprocket
14. Chain guide
15. Idler sprocket
16. Chain tension arm
17. Timing chain tensioner (lower)
18. Suitable pin



1. Camshaft sprocket cover
2. Front cover
3. Generator adjustment bar

⇦ Front

LIQUID GASKET APPLICATION PLACES



Removal

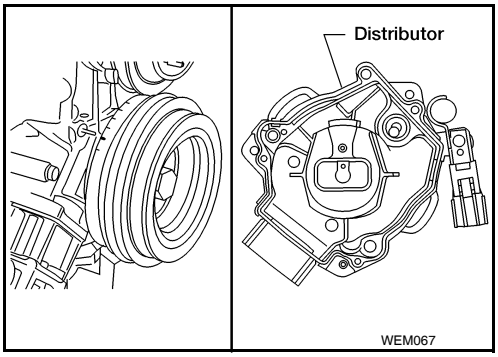
INFOID:0000000006927460

CAUTION:

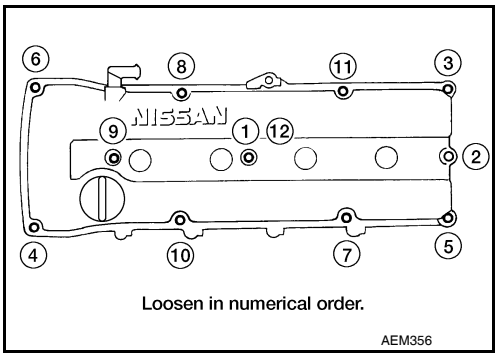
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing chain tensioners or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt threads and seat surfaces when installing camshaft sprockets and crankshaft pulley.**
- **Do not spill engine coolant on drive belts.**

UPPER TIMING CHAIN

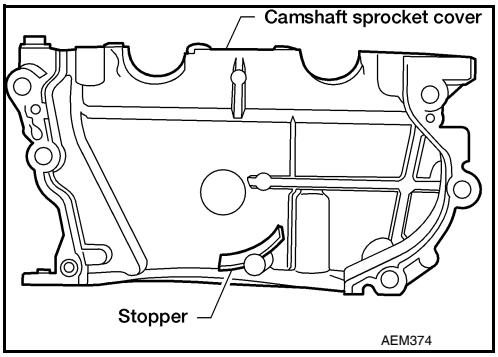
1. Remove the air cleaner assembly. Refer to EM-17, "Removal and Installation".
2. Remove the spark plug wires. Refer to EM-19, "Removal and Installation".
3. Set No.1 piston at TDC on its compression stroke.



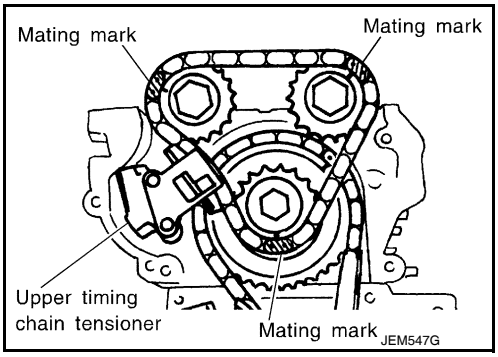
4. Remove the vacuum hoses, electrical harness connectors, and harness clamps.
5. Remove the power steering belt, if equipped. Refer to EM-16, "Removal and Installation".
6. Remove the power steering pump, if equipped, and position it to one side. Remove the idler pulley and bracket.
7. Remove the rocker cover, loosen and remove the rocker cover bolts in the numerical order as shown.



8. Remove the camshaft sprocket cover.



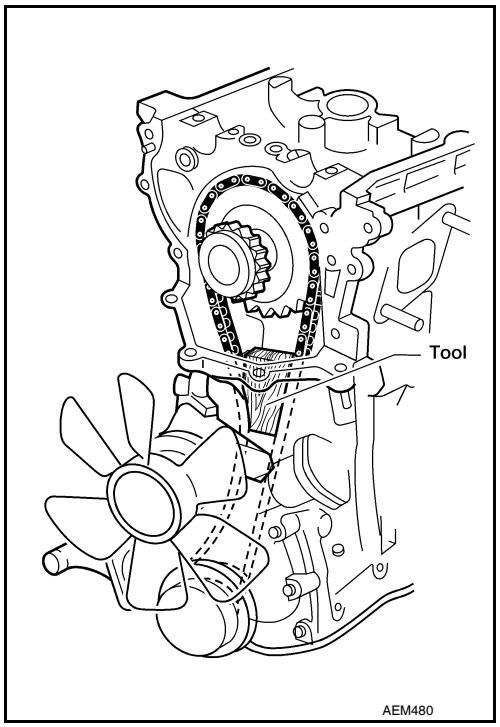
9. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the cam sprockets and idler sprocket.



10. Remove cam sprocket bolts, cam sprockets and upper timing chain.

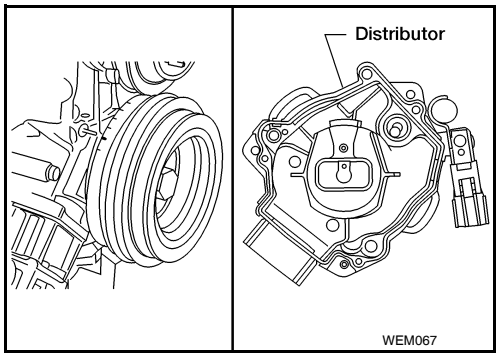
IDLER SPROCKET

1. Remove upper timing chain.
2. If not removing the lower cover, support lower timing chain using a suitable tool to prevent the chain tensioner spring from coming out.
   NOTE:
   This step is only to be applied when the lower cover is not being removed.
3. Remove the idler sprocket.



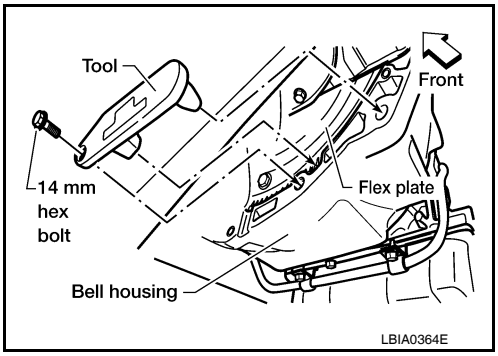
LOWER TIMING CHAIN

1. Drain the coolant by removing the cylinder block drain plug and opening the radiator drain cock. Refer to CO-10, "Changing Engine Coolant".
2. Drain the engine oil. Refer to LU-7, "Changing Engine Oil".
3. Remove the intake air duct.
4. Remove the following parts:
   - Generator drive belt
   - A/C compressor drive belt, if equipped.
   - Cooling fan with coupling
   - Radiator shroud
5. Remove the A/C compressor, if equipped, without disconnecting the A/C hoses and position it to the side, supporting it with wire.
6. Remove the idler pulley and bracket, if equipped.
7. Set the No. 1 piston to TDC on its compression stroke.
8. Remove the distributor.

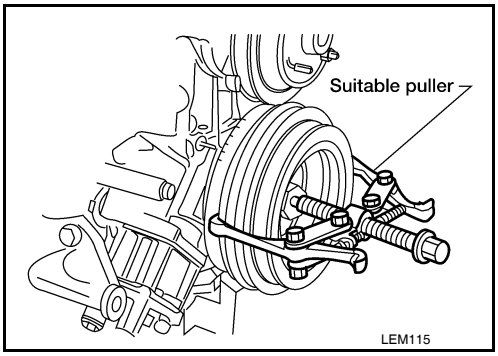


9. Remove the crankshaft bolt.
   - Remove the rear plate and install Tool to prevent crankshaft rotation.

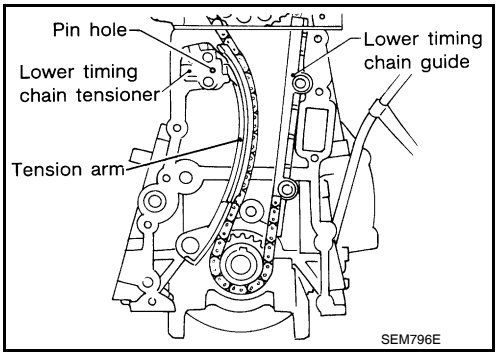
   Tool number : — (J-45499)



10. Remove the crankshaft pulley with a suitable puller.

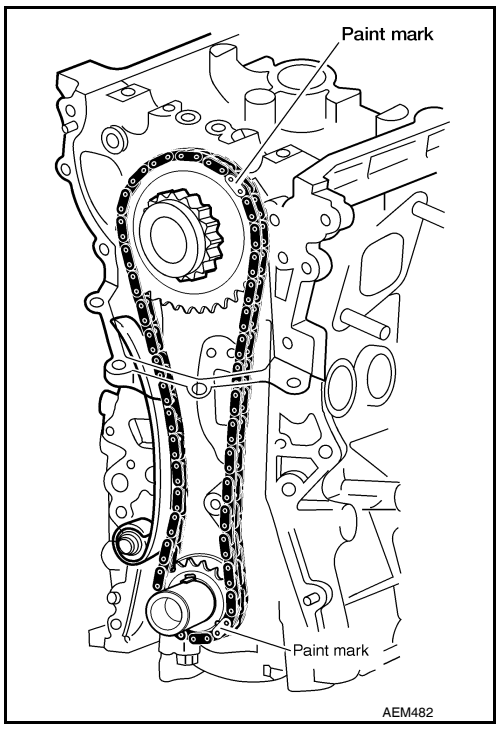


11. Remove the oil pan. Refer to EM-21, "Removal".
12. Remove the oil pump, distributor drive shaft, and the oil pickup strainer.
13. Remove the front cover.
    CAUTION:
    Be careful not to tear or damage the cylinder head gasket.
14. Remove the following parts.
    - Release the timing chain tensioner by pushing the piston in and inserting a suitable pin into the pin hole.
    - Chain tension arm
    - Lower timing chain guide



15. Remove the upper timing chain.

16. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the crankshaft sprocket and idler sprocket.

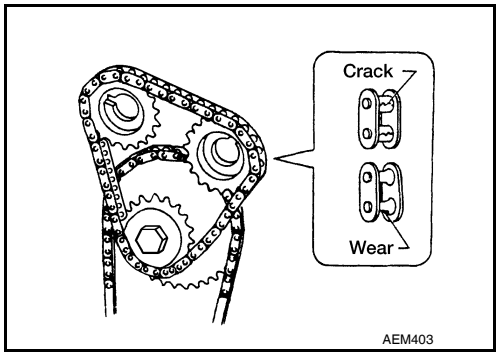


17. Remove the lower timing chain, crankshaft sprocket, and idler sprocket.

Inspection

INFOID:0000000006927461

Check for cracks and excessive wear at the roller links. Replace the chain if necessary.

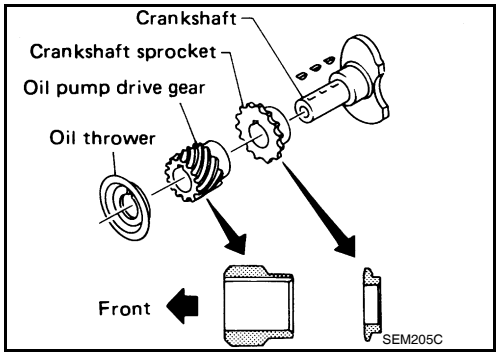


Installation

INFOID:0000000006927462

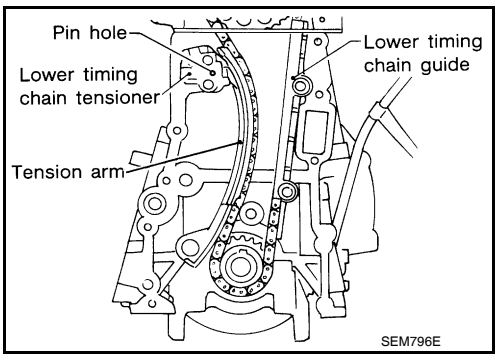
LOWER TIMING CHAIN

1. Install crankshaft sprocket.
   - Make sure that the mating marks of crankshaft sprocket face the front of the engine.

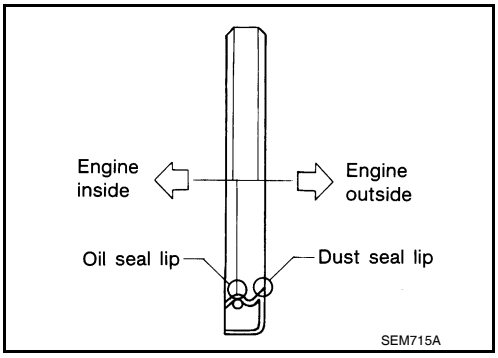


2. Install the idler sprocket and lower timing chain using the mating marks and the paint marks made during the removal process.
   CAUTION:
   Be careful not to tear or damage the cylinder head gasket.

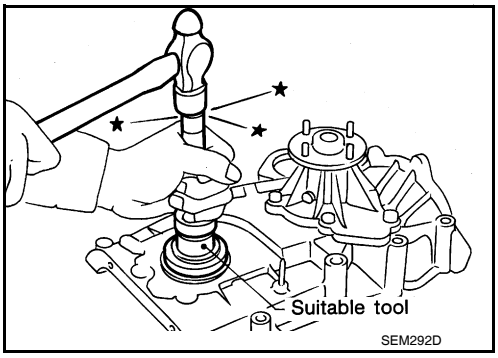
3. Install the chain guide and the chain tension arm.



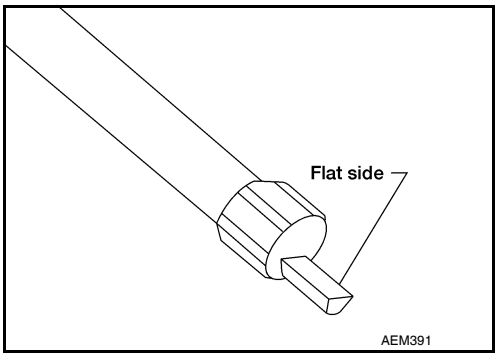
4. Install the lower chain tensioner and remove the pin securing the piston in the tensioner body.
5. Install the front cover and oil seal.
   - Using a scraper or other suitable tool remove all traces of liquid gasket from the cylinder block and front cover mating surfaces.
   - Install a new crankshaft seal in the front cover.
   - Apply a continuous bead of Genuine Silicone RTV Sealant or equivalent, to the front cover. Refer to GI-43, "Recommended Chemical Product and Sealant".



   - Install a new front oil seal using a suitable tool. Refer to EM-33, "Replacement".

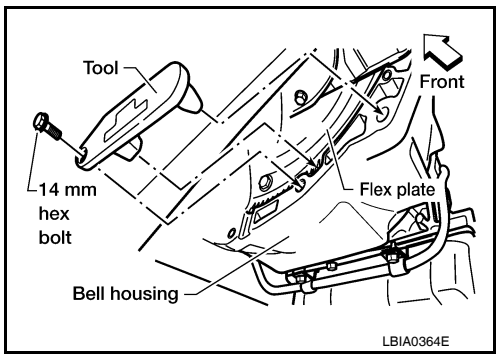


   - Apply Genuine Silicone RTV Sealant on the head gasket surface. Refer to GI-43.
   - Install the front engine cover.
6. Install oil strainer and oil pan. Refer to EM-22, "Installation".
7. Install the oil pump and distributor drive shaft.
   - Make sure the flat side of the distributor drive shaft is facing the engine. Failure to do so will result in the distributor being out of time.
8. Install the crankshaft pulley and crankshaft pulley bolt. Refer to EM-12, "Removal and Installation".



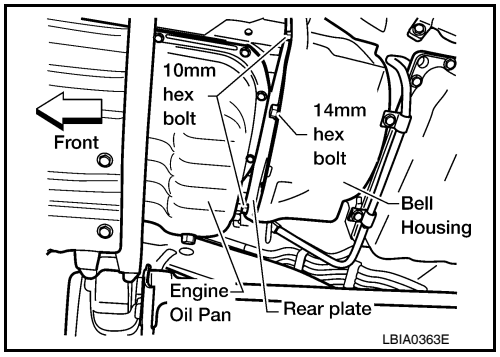
9. If installed, remove Tool.

Tool number : — (J-45499)



10. Install the rear plate.

Rear plate bolts
10 mm hex : 3 - 4 N·m (0.3 - 0.4 kg-m, 32 - 35 in-lb)
14 mm hex : 16 - 22 N·m (1.6 - 2.2 kg-m, 12 - 16 ft-lb)



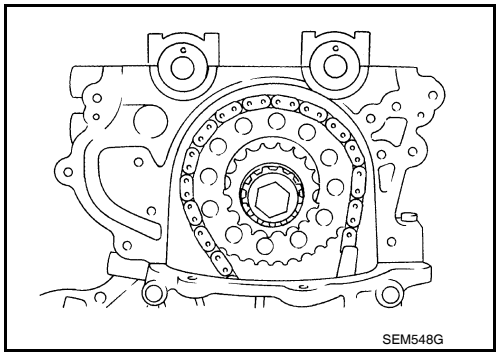
11. Install the A/C compressor and idler pulley bracket, if equipped. Refer to MTC-68, "Removal and Installation for Compressor".
12. Install the radiator shroud and cooling fan with coupling. Refer to CO-12, "Removal and Installation".
13. Install the A/C compressor, generator, and power steering pump drive belts, if equipped. Refer to EM-15, "Checking Drive Belts".
14. Install the intake air duct.

IDLER SPROCKET

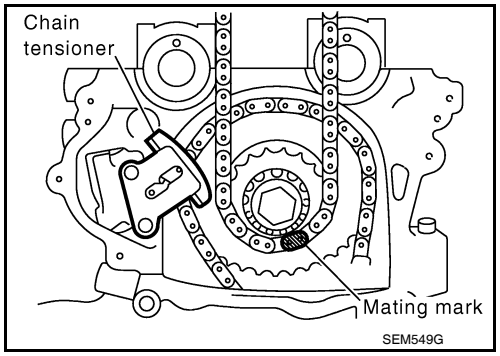
Install the lower timing chain.

UPPER TIMING CHAIN

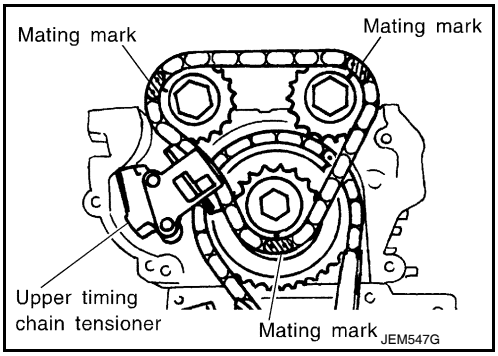
1. Install the lower timing chain and idler sprocket.



2. Install the upper timing chain and sprockets, aligning the paint marks made during removal as shown.

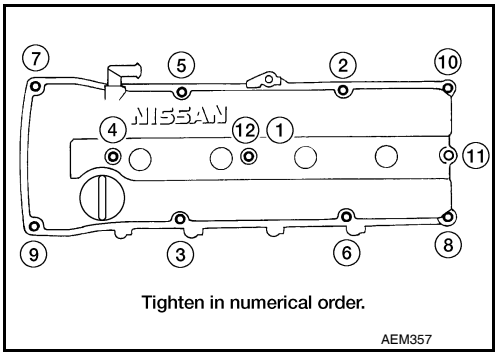


3. Install the chain tensioner. Remove the pin holding the tensioner piston in the bore of the tensioner.
   - Check that the timing chain mating marks are aligned so that the timing chain is correctly installed.

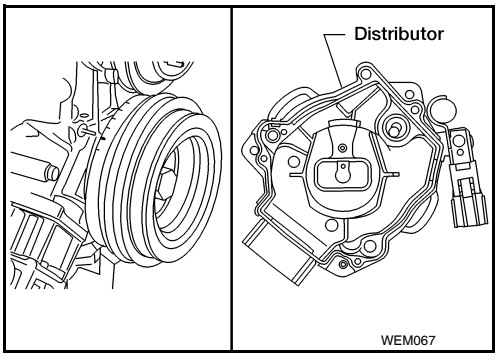


4. Install the camshaft sprocket cover:
   CAUTION:
   Do not to tear or damage the cylinder head gasket.
   Do not let the upper timing chain slip or jump on the sprockets when installing the camshaft sprocket cover.
   - Use a scraper to remove all traces of liquid gasket from mating surfaces of the engine block and camshaft sprocket cover.
   - Apply liquid gasket on the head gasket surface.
   - Apply a continuous bead of liquid gasket to the cylinder head camshaft sprocket cover. Refer to EM-4, "Precaution for Liquid Gasket". Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".
5. Install the rocker cover gasket on the rocker cover.
   - Apply a continuous bead of liquid gasket to the cylinder head camshaft sprocket cover. Refer to EM-4, "Precaution for Liquid Gasket". Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant"
6. Install the rocker cover. Tighten the bolts in the numerical order as shown.

   Rocker cover bolts : 8 - 11 N·m (0.8 - 1.1 kg-m, 69 - 95 in-lb)



7. Install the distributor, align the distributor to the mark as shown.



8. Install the vacuum hoses, electrical harnesses, connectors, and harness clamps.

OIL SEAL

Replacement

INFOID:0000000006927463

VALVE OIL SEAL

Removal

1. Remove the rocker cover.
2. Remove the camshaft. Refer to EM-24.
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

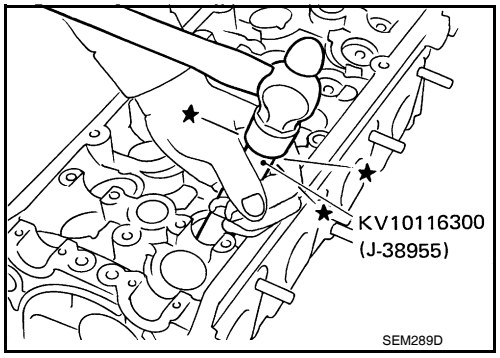
Tool number : KV10109210 (J-26336-B)

NOTE:
The piston must be at TDC on the compression stroke to prevent the valve from falling into the combustion chamber.

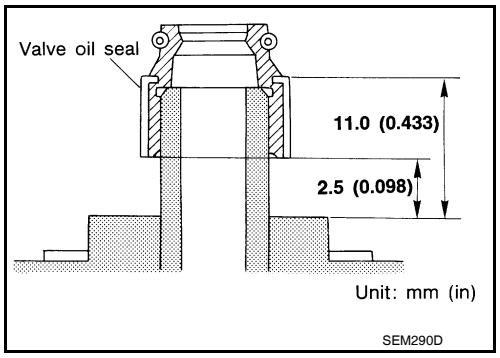
Installation

Installation is in the reverse order of removal.

- Apply engine oil to new valve oil seal and install it with Tool.



- The valve oil seal must be installed to specification over the valve stem opening as shown.



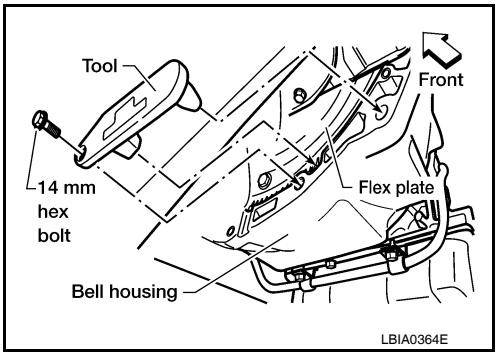
FRONT OIL SEAL

Removal

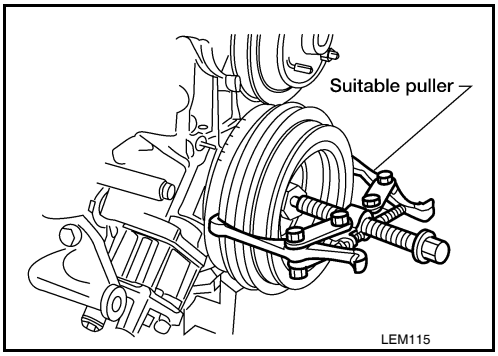
1. Remove engine undercover.
2. Remove radiator shroud. Refer to CO-12, "Component".

3. Remove the crankshaft bolt.
   • Remove the rear plate and install Tool to prevent crankshaft rotation.

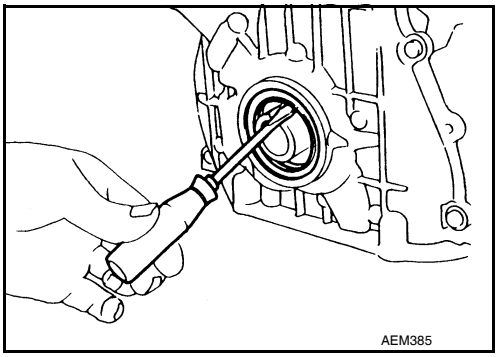
   Tool number : — (J-45499)



4. Remove the crankshaft pulley with a suitable puller.

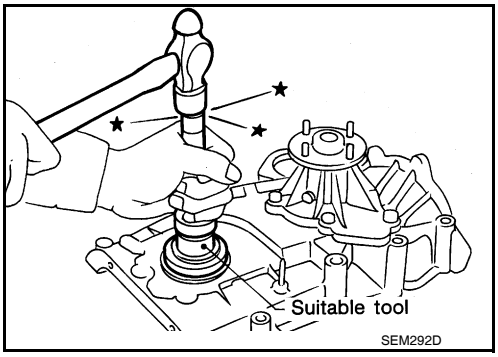


5. Remove front oil seal using suitable tool.
   CAUTION:
   Be careful not to scratch the front cover.

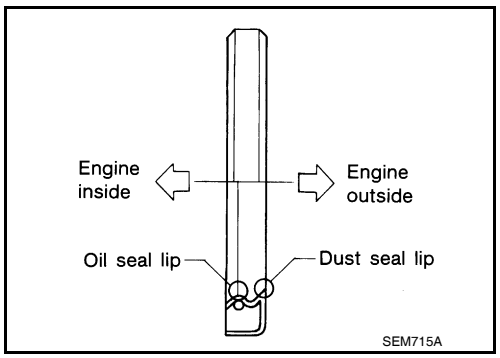


Installation

1. Apply engine oil to new oil seal and install it using a suitable tool.

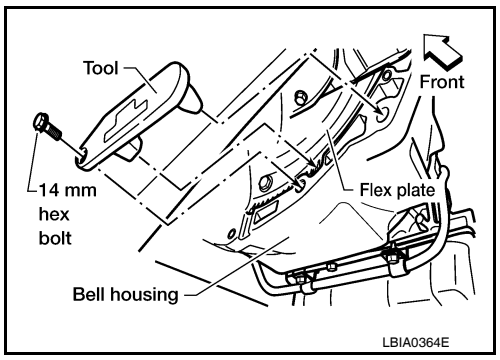


- Install the new oil seal in the direction shown.



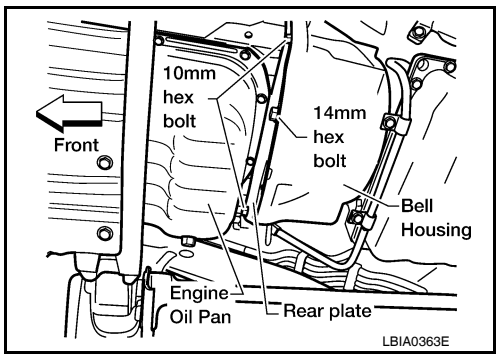
2. Install the crankshaft pulley. Refer to EM-12, "Removal and Installation".
3. If installed, remove Tool.

Tool number : — (J-45499)



4. Install the rear plate.

Rear plate bolts
10 mm hex : 3 - 4 N·m (0.3 - 0.4 kg-m, 32 - 35 in-lb)
14 mm hex : 16 - 22 N·m (1.6 - 2.2 kg-m, 12 - 16 ft-lb)

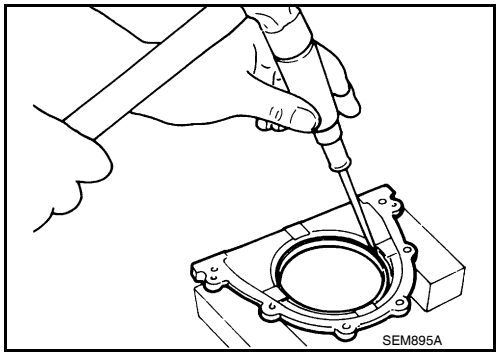


5. Install radiator shroud. Refer to CO-12, "Component".
6. Install engine undercover.

REAR OIL SEAL

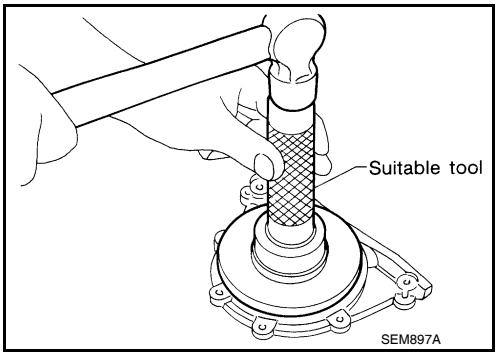
Removal

1. Remove the transmission. Refer to MT-12, "Removal and Installation".
2. Remove the flywheel. Refer to EM-53, "Component".
3. Remove the rear oil seal retainer.
4. Remove the rear oil seal from the retainer.
   CAUTION:
   Be careful not to scratch the rear oil seal retainer.

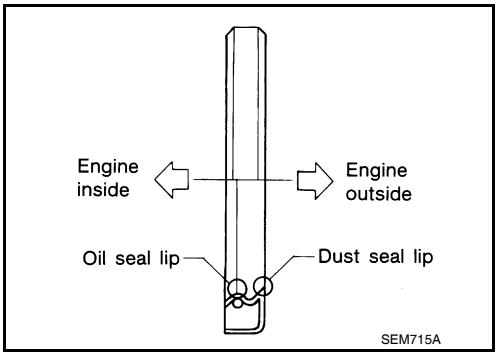


Installation

1. Apply engine oil to new oil seal and install it using suitable tool.



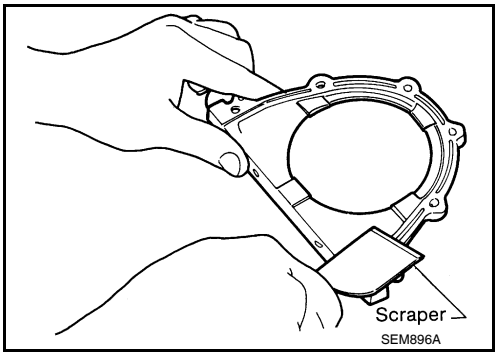
- Install the new oil seal in the direction shown.



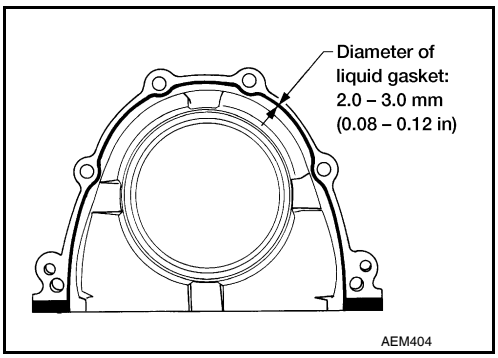
2. Install rear oil seal retainer.

Rear oil seal retainer bolts	**: 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 56 - 66 in-lb)**

a. Before installing rear oil seal retainer, remove all traces of liquid gasket from mating surface using a scraper as shown. Also remove all traces of the old liquid gasket from the mating surface of the cylinder block.



b. Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer. Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-43.
- Apply the liquid gasket around the inner side of the bolt holes.



3. Install the flywheel. Refer to EM-53, "Component".
4. Install the transmission. Refer to MT-12, "Removal and Installation".

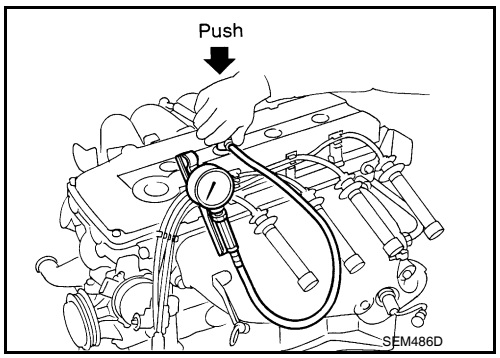
CYLINDER HEAD

On-Vehicle Service

INFOID:0000000006927464

CHECKING COMPRESSION PRESSURE

1. Warm up the engine.
2. Turn the ignition switch OFF.
3. Release the fuel pressure.
   Refer to EC-34, "Fuel Pressure Check".
4. Remove all of the spark plugs.
   • Clean area around plug with compressed air before removing the spark plug.
5. Disconnect the camshaft position sensor harness connector at the distributor.
6. Remove the fuel injector fuse No. **3** on FUSE BLOCK (J/B) behind the driver side instrument lower panel.
7. Attach a compression tester to the No. 1 cylinder as shown.
8. Depress the accelerator pedal fully to keep the throttle valve wide open.
9. Crank the engine and record the highest gauge indication.



10. Repeat the measurement on each cylinder.
    • Always use a fully-charged battery to obtain specified engine speed.

Compression	**: kPa (kg/cm^2, psi)/300 rpm**
Standard	**: 1,226 (12.5, 178)**
Minimum	**: 1,030 (10.5, 149)**
Difference limit between cylinders	**: 98 (1.0, 14)**

11. If the compression in one or more cylinders is low:

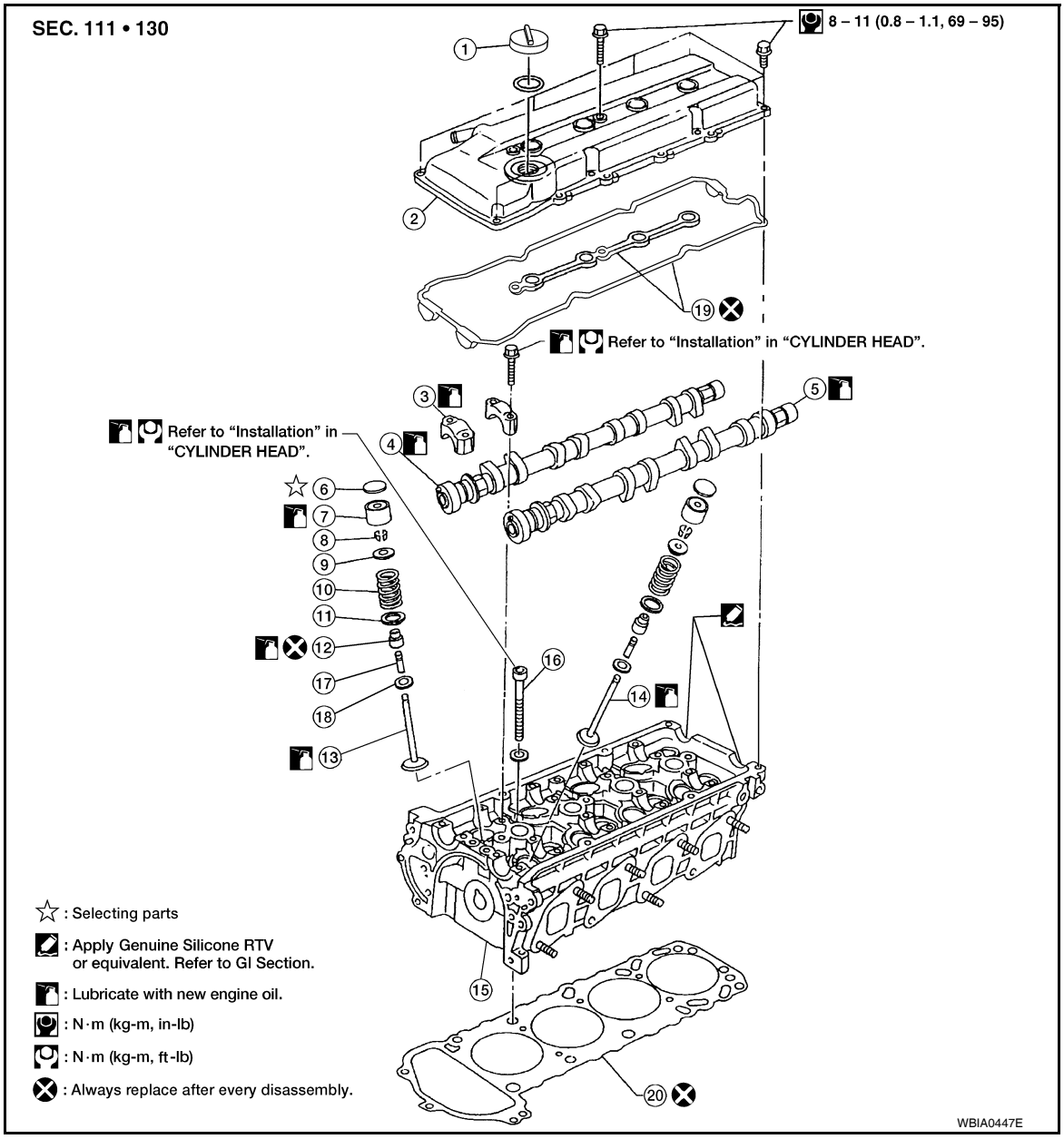
a. Pour a small amount of engine oil into the cylinders through the spark plug hole.

b. Retest the compression.
   • If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.
   • If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to EM-39, "Inspection", EM-39, "Inspection". If valve or valve seat is damaged excessively, replace it.
   • If compression in any two cylinders adjacent cylinders is low, and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.

12. Reinstall the spark plugs, fuel injector fuse, fuel pump fuse, and reconnect camshaft position sensor harness connector at the distributor.
13. Erase the DTC stored in the ECM.
    Refer to EC-36, "Emission-related Diagnostic Information".
    CAUTION:
    Always erase the DTC after checking compression.

Component

INFOID:0000000006927465



1. Oil filler cap
2. Rocker cover
3. Camshaft bracket
4. Intake camshaft
5. Exhaust camshaft
6. Adjusting shim
7. Valve lifter
8. Valve cotter
9. Spring retainer
10. Valve spring
11. Spring seat
12. Valve oil seal
13. Intake valve
14. Exhaust valve
15. Cylinder head
16. Cylinder head bolt
17. Valve guide
18. Valve seat
19. Rocker cover gaskets
20. Cylinder head gasket

Removal

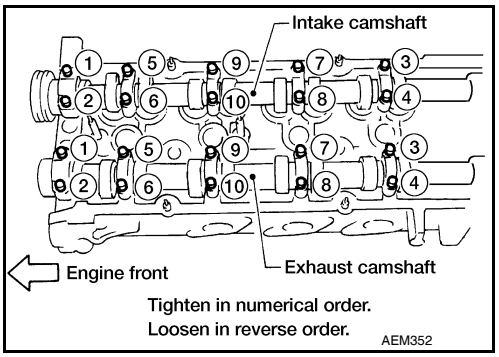
INFOID:0000000006927466

CAUTION:

- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to threads and seat surfaces when installing cylinder head, camshaft sprocket, crankshaft pulley, and camshaft bracket.**
- **Attach tags to valve lifters so as not to mix them up.**

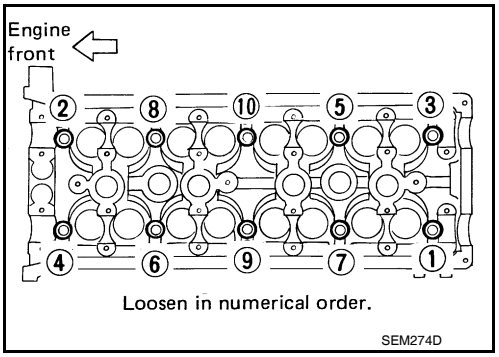
- **Before removing camshaft and idler sprockets, apply paint marks to them for re-timing.**

1. Remove upper timing chain and idler sprocket. Refer to EM-25, "Removal" and EM-25, "Removal".
   - For re-timing during cylinder head removal and installation, apply paint marks to the camshaft sprockets, upper timing chain, lower timing chain, and idler sprocket.
2. Remove camshaft brackets and camshafts. Remove the bolts in the reverse order as shown.
   - Mark the part with their original position and direction for correct placement for installation.



3. Remove the cylinder head bolts in numerical order as shown.
   - Loosen the cylinder head bolts in two or three steps.

CAUTION:
Remove the bolts in the correct numerical order to avoid warping or cracking the cylinder head.



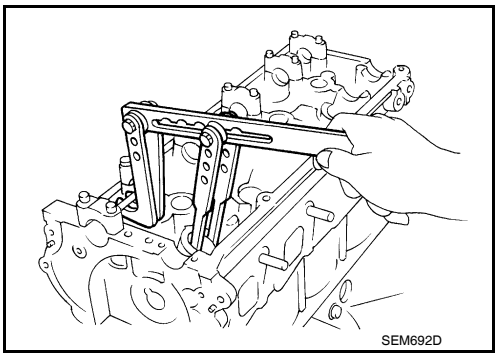
4. Remove the cylinder head and cylinder head gasket.

Disassembly

INFOID:0000000006927467

1. Remove the intake manifold and exhaust manifold. Refer to EM-12, "Removal and Installation".
2. Remove the valve components using Tool as shown.

Valve spring compressor : KV101092S0 (J26336-B)



3. Remove the valve oil seals using a suitable tool.

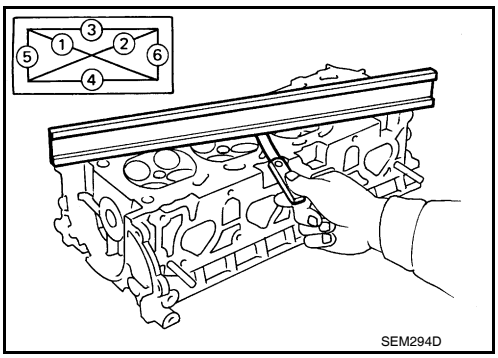
Inspection

INFOID:0000000006927468

CYLINDER HEAD DISTORTION

1. Clean the sealing surface of the cylinder head.

2. Use a reliable straightedge and feeler gauge to check the flatness of cylinder head surface. Check the cylinder head sealing surface flatness along the six positions as shown.



Cylinder head surface flatness

Limit : 0.1 mm (0.004 in)

If it exceeds the limit, replace or resurface the cylinder head.

3. Resurface the cylinder head as necessary to specification.
The limit of cylinder head resurfacing is determined by the cylinder block resurfacing:
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".

Maximum limit : A + B = 0.2 mm (0.008 in)

4. After resurfacing, the cylinder head,
• Check that the camshaft rotates freely by hand. If resistance is felt, the cylinder head must be replaced.

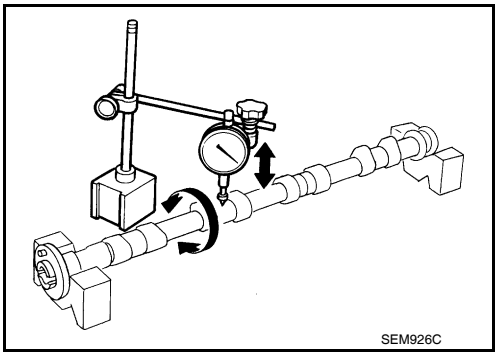
Nominal cylinder head height : 126.3 - 126.5 mm (4.972 - 4.980 in)

CAMSHAFT VISUAL CHECK

Check the camshaft for scratches, seizure, and wear.

CAMSHAFT RUNOUT

1. Measure the camshaft runout at the center of the journal.



Runout (total indicator reading)

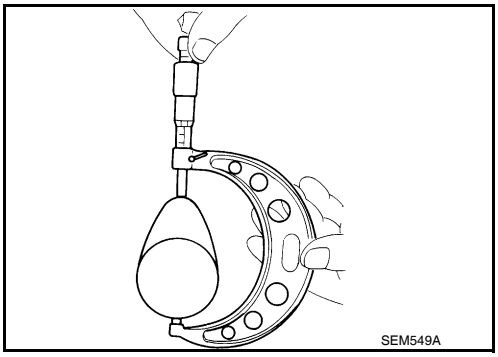
Standard : less than 0.02 mm (0.0008 in)

Limit : 0.04 mm (0.0016 in)

2. If the camshaft runout exceeds the limit, replace the camshaft.

CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.



Standard cam height

Intake : 41.755 - 41.945 mm (1.644 - 1.651 in)

Exhaust : 41.815 - 42.005 mm (1.646 - 1.654 in)

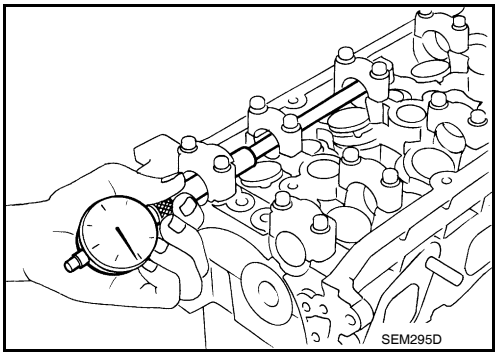
Cam height wear limit

Intake & Exhaust : 0.2 mm (0.008 in)

2. If wear is beyond the limit, replace camshaft.

CAMSHAFT JOURNAL CLEARANCE

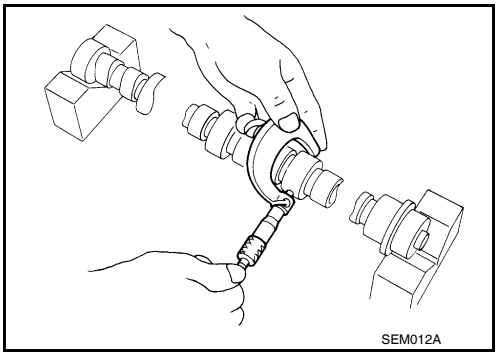
1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.



Standard inner diameter

No. 1 to No. 5 journals : 28.000 - 28.025 mm (1.1024 - 1.1033 in)

3. Measure outer diameter of camshaft journal.



Standard outer diameter

No. 1 to No. 5 journals : 27.935 - 27.955 mm (1.0998 - 1.1006 in)

4. If clearance exceeds the limit, replace camshaft and/or cylinder head.

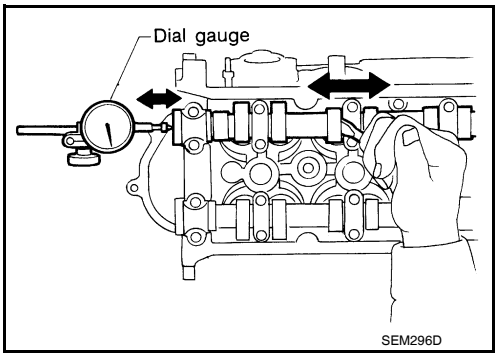
Camshaft journal clearance

Standard : 0.045 - 0.090 mm (0.0018 - 0.0035 in)

Limit : 0.12 mm (0.0047 in)

CAMSHAFT END PLAY

1. Install camshaft in cylinder head.
2. Measure camshaft end play.



Camshaft end play

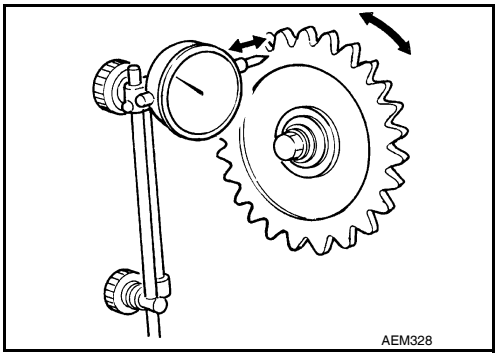
Standard : 0.070 - 0.148 mm (0.0028 - 0.0058 in)

Limit : 0.2 mm (0.008 in)

3. If end play exceeds the limit, replace camshaft and remeasure camshaft end play.
4. If end play still exceeds the limit after replacing camshaft, replace the cylinder head.

CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.



Runout (total indicator reading)

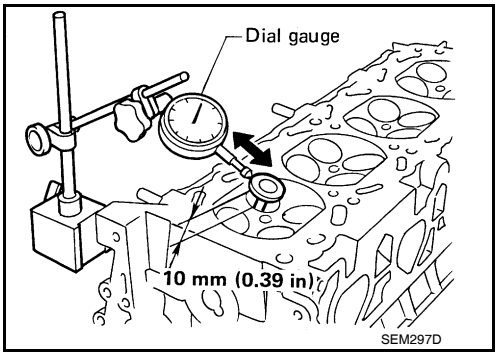
Limit : 0.15 mm (0.0059 in)

3. If it exceeds the limit, replace camshaft sprocket.

VALVE GUIDE CLEARANCE

1. Measure valve deflection as shown. Valve and valve guide mostly wear in this direction.

Valve deflection limit (dial gauge reading)
Intake & Exhaust : 0.2 mm (0.008 in)



2. If the valve exceeds the deflection limit, check the valve to valve guide clearance:

a. Measure valve stem diameter and valve guide inner diameter.

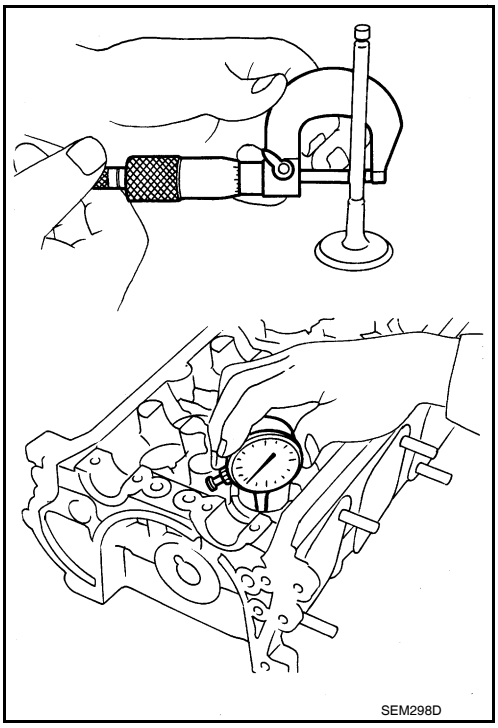
b. Check that clearance is within specification.
Valve to valve guide clearance = valve guide inner diameter - valve stem diameter.

Unit: mm (in)

Valve	Standard	Limit
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)

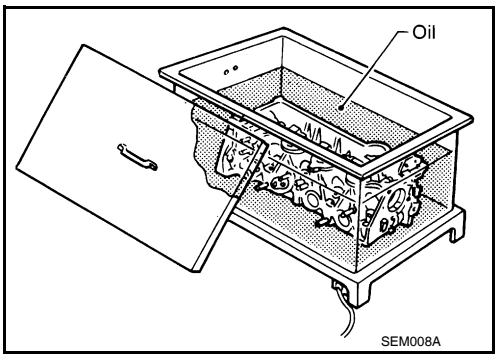
c. If the clearance exceeds the limit, replace the valve and remeasure the clearance.

d. If the clearance still exceeds the limit after replacing the valve, replace the valve guide.

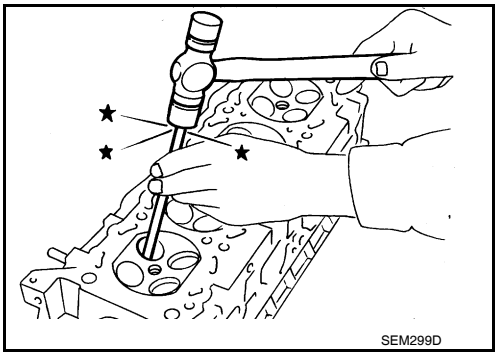


VALVE GUIDE REPLACEMENT

1. To remove the valve guide, heat the cylinder head to 120° - 140°C (248° - 284°F) by soaking in heated oil.

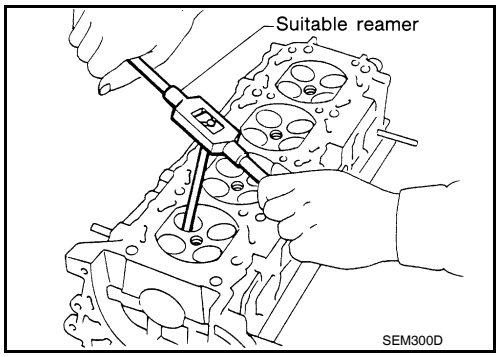


2. To remove the valve guide, use a press [less than 20 kN (2 metric ton, 2.2 US ton, 2.0 Imp. ton) pressure] or hammer and suitable tool, to slide the valve guide out of the cylinder head.



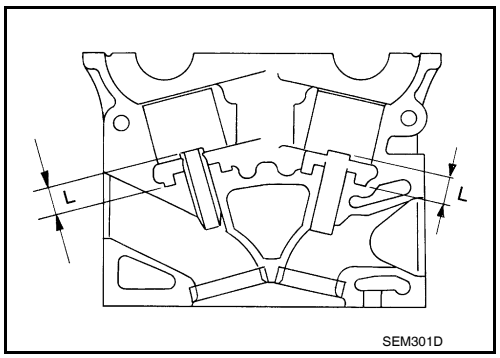
3. Ream the cylinder head valve guide hole.

Valve guide hole diameter (for service parts)
Intake & Exhaust : 11.175 - 11.196 mm (0.4400 - 0.4408 in)



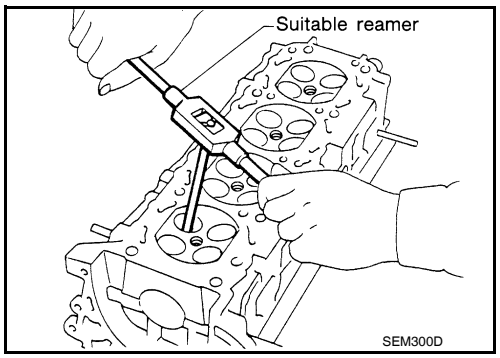
4. Heat cylinder head to 120° - 140°C (248° - 284°F) in heated oil and press the replacement valve guide into the valve guide hole in the cylinder head. Press the valve guide in to the specified height "L" as shown.

Projection "L" : 13.3 - 13.9 mm (0.524 - 0.547 in)



5. Ream the new replacement valve guide.

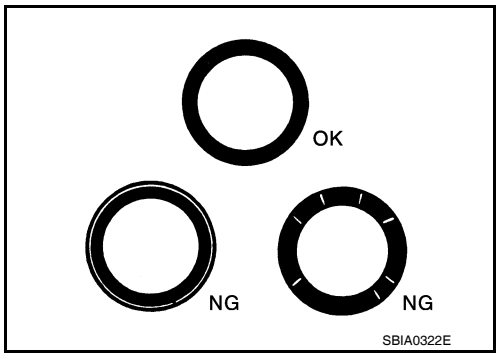
Finished size
Intake & Exhaust : 7.000 - 7.018 mm (0.2756 - 0.2763 in)



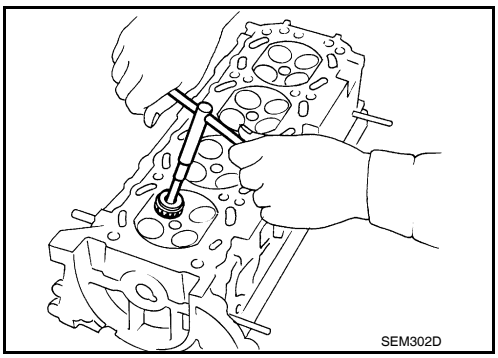
VALVE SEATS

Check valve seats for pitting at contact surface. Resurface or replace if excessively worn.

- Before repairing the valve seats, check the valves and valve guides for wear as shown. If they are worn, replace them. Then resurface the valve seat as necessary.

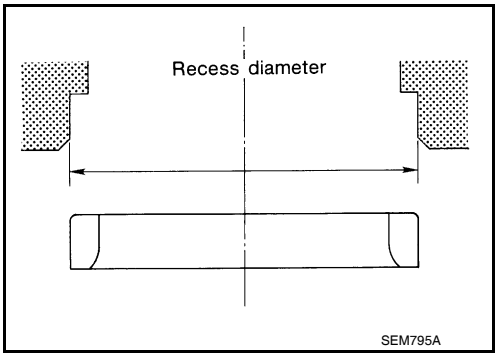


- Use both hands to resurface the valve seat uniformly using a suitable tool, as shown.



REPLACING VALVE SEAT

1. Bore out the old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in the cylinder head. Set the machine depth stop to prevent damage.



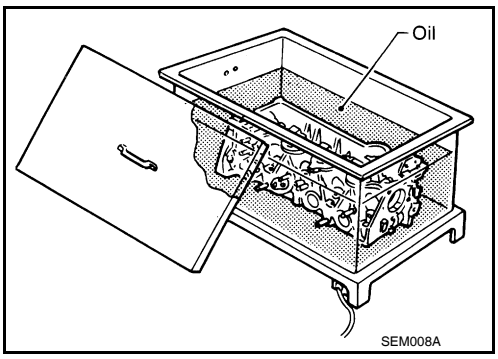
2. Ream the cylinder head valve seat recess.

Reaming bore for service valve seat

Oversize	**: 0.5 mm (0.020 in)**
Intake	**: 38.000 - 38.016 mm (1.4961 - 1.4967 in)**
Exhaust	**: 32.700 - 32.716 mm (1.2874 - 1.2880 in)**

CAUTION:
Use the valve guide center for a reference point for reaming so the valve and valve seat will have the correct fit.

3. Heat the cylinder head to 120° - 140°C (248° - 284°F) in heated oil.

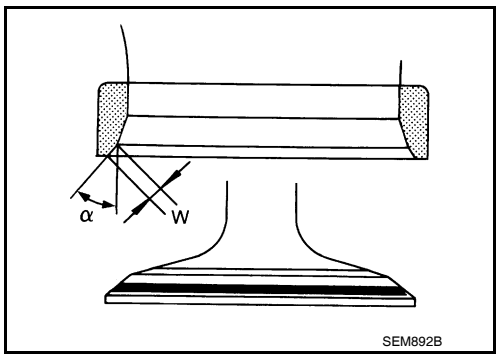


4. Press fit valve seat until it seats on the bottom of the recess.

5. Cut or grind valve seat using suitable tool to the specified dimensions.

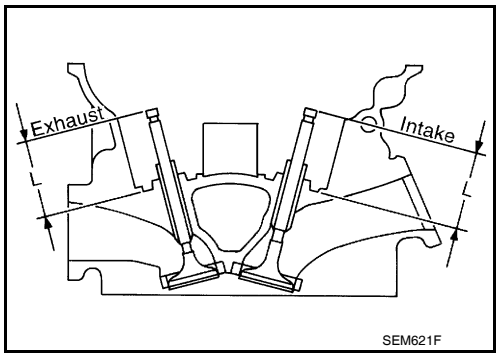
Seat face “α” : 45° 15′ - 45° 45′ degrees

Contacting width “W”
Intake : 1.48 - 1.63 mm (0.0583 - 0.0642 in)
Exhaust : 1.8 - 2.0 mm (0.071 - 0.079 in)



6. After cutting, lap valve seat with abrasive compound.
7. Check the valve seat dimensions. Refer to EM-68, "Valve".
8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 through 7 above, to adjust it. If it is longer, replace the valve seat with a new one.

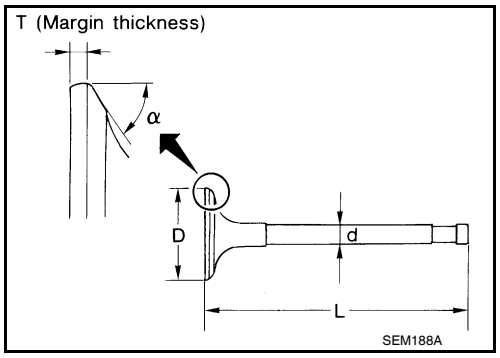
Valve seat resurface limit - height “L”
Intake : 42.02 - 42.52 mm (1.6543 - 1.6740 in)
Exhaust : 42.03 - 42.53 mm (1.6547 - 1.6744 in)



VALVE DIMENSIONS

Check dimensions of each valve. Refer to EM-68, "Valve". When valve head has been worn down to less than the margin thickness "T", replace the valve. Do not grind the valve stem more than the grinding limit specification.

Margin thickness "T" : 0.5 mm (0.020 in)
Valve stem tip grinding limit : 0.2 mm (0.008 in)



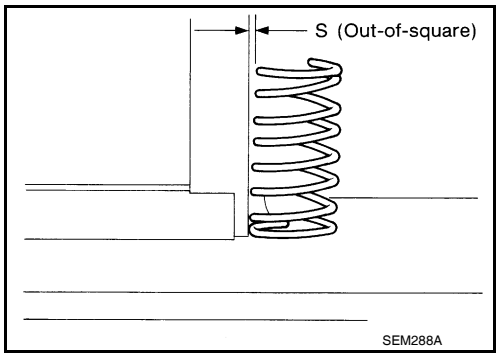
VALVE SPRING

Squareness

1. Measure the spring out-of-square dimension “S” as shown.

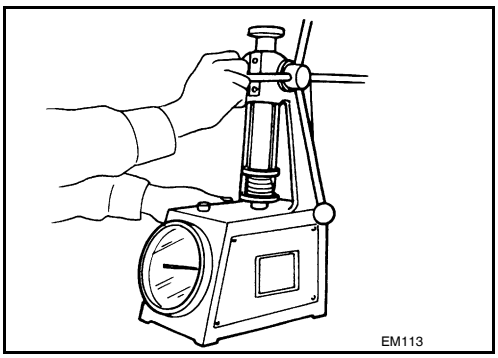
Out-of-square “S” : less than 2.2 mm (0.087 in)

2. If the out-of-square measurement exceeds the limit, replace the spring.



Pressure

1. Check the valve spring pressure at the specified spring height.

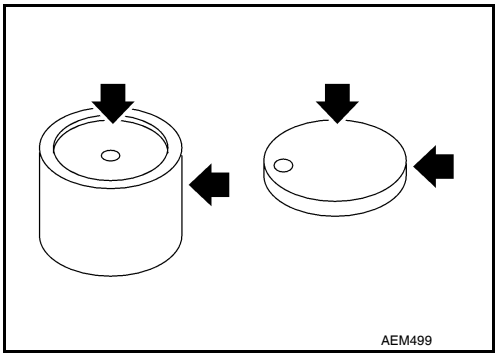


Pressure : N (kg, lb) at height mm (in)
Standard : 418.0 (42.6, 93.9) at 29.17 (1.1484)
Limit : 393.0 (40.1, 88.4) at 29.17 (1.1484)

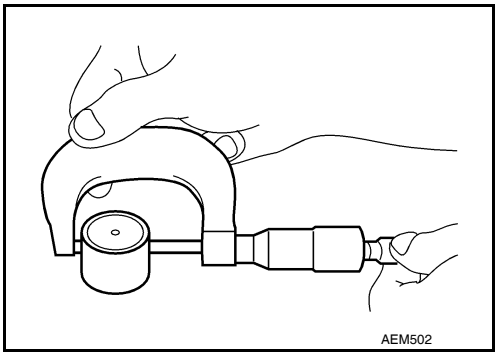
2. If not within specification, replace the spring.

VALVE LIFTER AND ADJUSTING SHIM

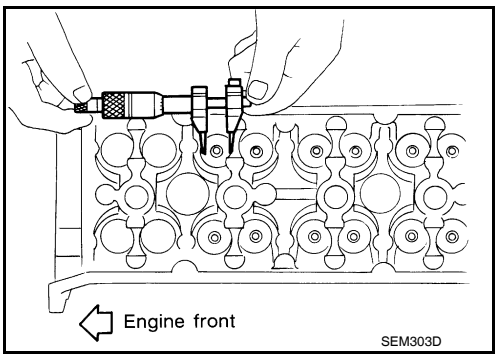
1. Visually check the valve lifter and adjusting shim contact and sliding surfaces for wear and scratches.



2. Check the diameter of the valve lifter as shown.



3. Check the diameter of the valve lifter guide bore as shown.



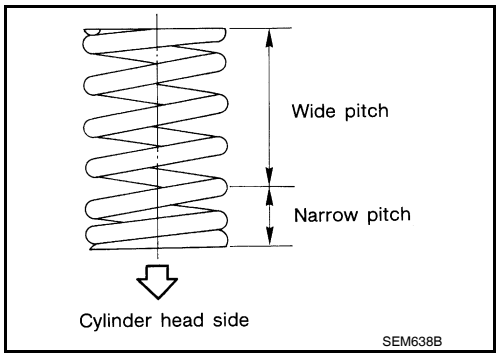
4. If the measurements exceed the standard diameter or clearance, replace valve lifter or cylinder head as necessary.

Valve lifter outer diameter : 33.960 - 33.975 mm (1.3370 - 1.3376 in)
Lifter guide bore diameter : 34.000 - 34.021 mm (1.3386 - 1.3394 in)
Valve lifter to valve lifter guide clearance : 0.025 - 0.061 mm (0.0010 - 0.0024 in)

Assembly

INFOID:0000000006927469

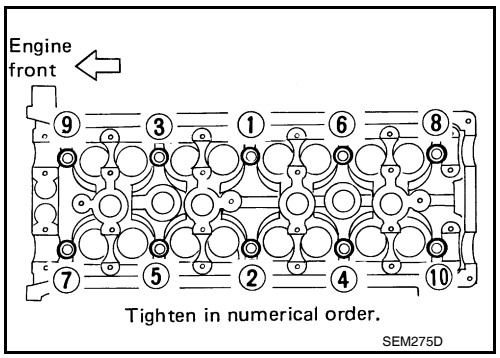
1. Install valve component parts.
   - Always use new valve oil seal. Refer to EM-33, "Replacement".
   - Before installing valve oil seal, install valve spring seat.
   - Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.
2. After installing the valve component parts, tap valve stem tip with a plastic hammer to assure a proper fit.



Installation

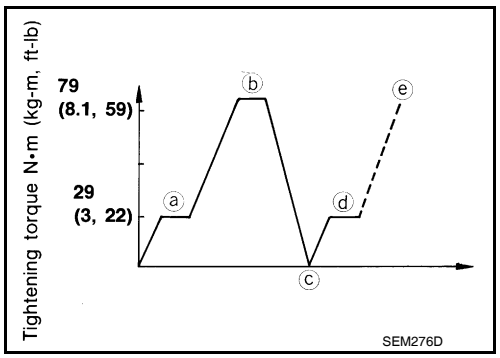
INFOID:0000000006927470

1. Tighten the cylinder head bolts in the numerical order as shown, using the five step procedure:



Cylinder head bolt tightening steps:

Step "a" : 29 N·m (3.0 kg-m, 22 ft-lb)
Step "b" : 79 N·m (8.1 kg-m, 59 ft-lb)
Step "c" : Loosen all bolts completely.
Step "d" : 25 - 34 N·m (2.5 - 3.5 kg-m, 18 - 25 ft-lb)
Step "e" : 86° - 91° degrees clockwise

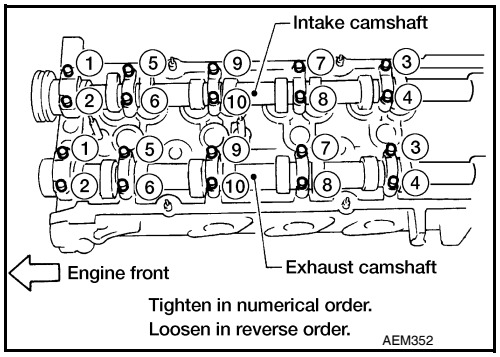


NOTE:
If an angle wrench is not available, mark all of the cylinder head bolts on the side facing engine front. Then turn each cylinder head bolt to the specified angle.

2. Set camshafts and camshaft brackets.
   - Set the dowel pins of both the intake and exhaust camshafts at 12 o'clock position when installing the camshafts.
3. Tighten the camshaft bracket bolts in the order shown using two steps:
   - Apply new engine oil to bolt threads and seat surfaces.

Camshaft bracket bolt tightening steps

Step 1 : 2 N·m (0.2 kg-m, 17 in-lb)
Step 2 : 9 - 11.8 N·m (0.92 - 1.2 kg-m, 79.9 - 104.2 in-lb)



4. Install upper timing chain and idler sprocket. Refer to EM-29, "Installation", EM-29, "Installation".

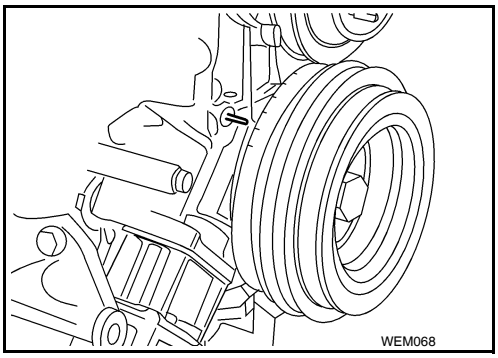
Valve Clearance

INFOID:0000000006927471

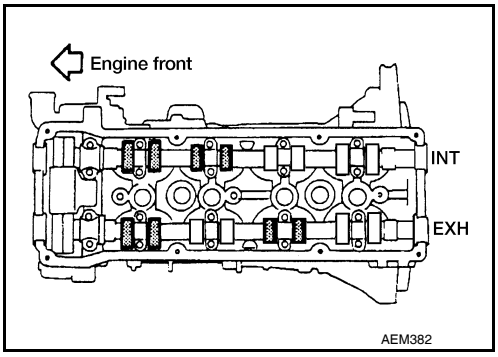
CHECKING

Check valve clearance while engine is warm but not running.

1. Remove the following parts:
   - Rocker cover
   - All spark plugs
2. Set No. 1 cylinder at TDC on its compression stroke.
   - Align pointer with TDC mark on crankshaft pulley.
   - Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.
     If not, turn crankshaft one revolution (360°) and align as above.



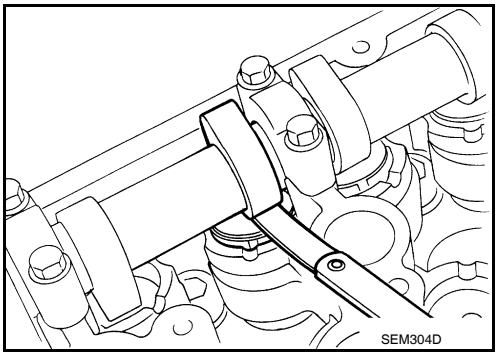
3. Check only those valves as shown.



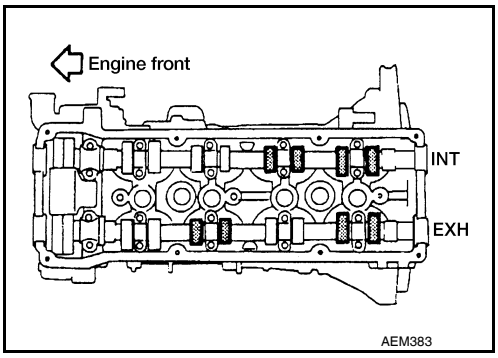
4. Using a feeler gauge, measure clearance between valve lifter and camshaft.
   - Record any valve clearance measurements which are out of specification. They will be used later to determine the required replacement adjusting shim.

Valve clearance (hot)

Intake	**: 0.31 - 0.39 mm (0.012 - 0.015 in)**
Exhaust	**: 0.39 - 0.47 mm (0.015 - 0.019 in)**



5. Turn crankshaft one revolution (360° degrees) and align mark on crankshaft pulley with pointer.
6. Check only those valves as shown.
   - Use the same procedure as described in step 4.



7. If all of the valve clearances are within specification, install the following parts:
   - Rocker cover
   - All spark plugs

ADJUSTING

CAUTION:

Adjust the valve clearance while engine is cold.

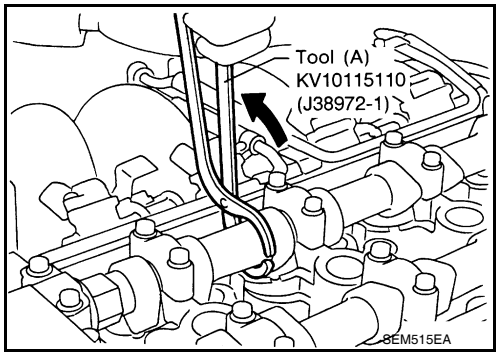
1. Turn the crankshaft to position the camshaft lobe on the valve that must be adjusted upward.
2. Place Tool (A) around camshaft as shown.

   CAUTION:

   Before placing Tool (A), rotate notch toward the center of the cylinder head as shown, to simplify the shim removal.
3. Rotate Tool (A) so that lifter is pushed down.

   CAUTION:

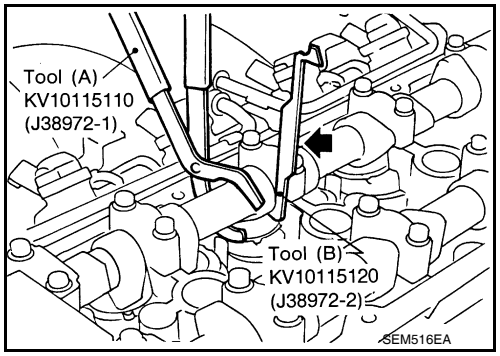
   Be careful not to damage the cam surface with Tool (A).



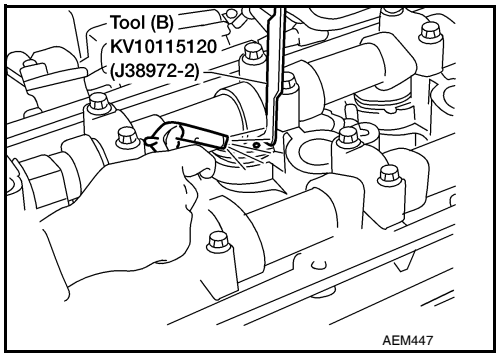
4. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.

   CAUTION:

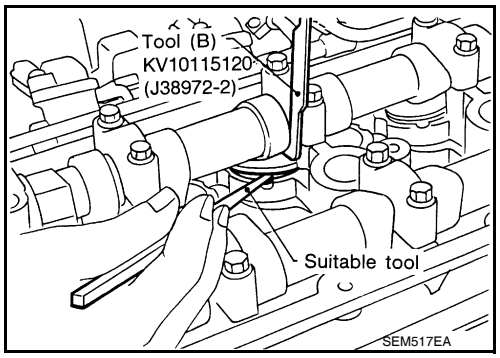
   - **Tool (B) must be placed as close to camshaft bracket as possible.**
   - **Be careful not to damage cam surface with Tool (B).**
5. Remove Tool (A).



6. Rotate the adjusting shim until a hole is visible. Blow air into the hole to separate the adjusting shim from the valve lifter.

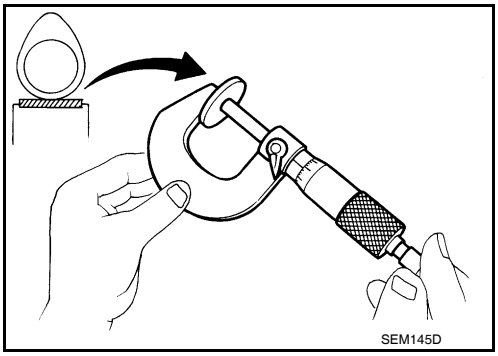


7. Remove the adjusting shim using a small screwdriver and a magnetic finger or suitable tool.



8. Calculate the replacement adjusting shim size.

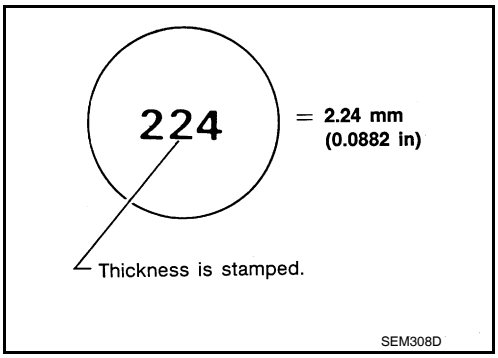
a. Using a micrometer to determine the thickness of the removed adjusting shim.



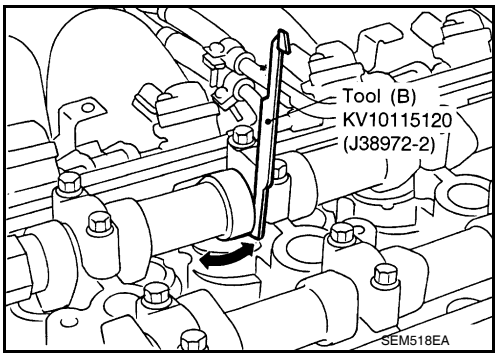
b. Calculate the thickness of the new adjusting shim so that the valve clearance comes within the specified values.
N = Thickness of new shim
R = Thickness of removed shim
M = Measured valve clearance

Intake and exhaust shim calculation : N = R + [M – 0.37 mm (0.0146 in)]

c. Select a new adjusting shim with the thickness as close as possible to the calculated value "N".
Refer to EM-68, "Valve".
NOTE:
Shims are available in thicknesses from 1.90 - 2.68 mm (0.0748 - 0.1055 in), in increments of 0.02 mm (0.0008 in). The adjusting shim thickness is stamped on the bottom of the adjusting shim as shown.



9. Install the new adjusting shim using a suitable tool.
CAUTION:
Install the adjusting shim with the surface on which the thickness is stamped facing down.

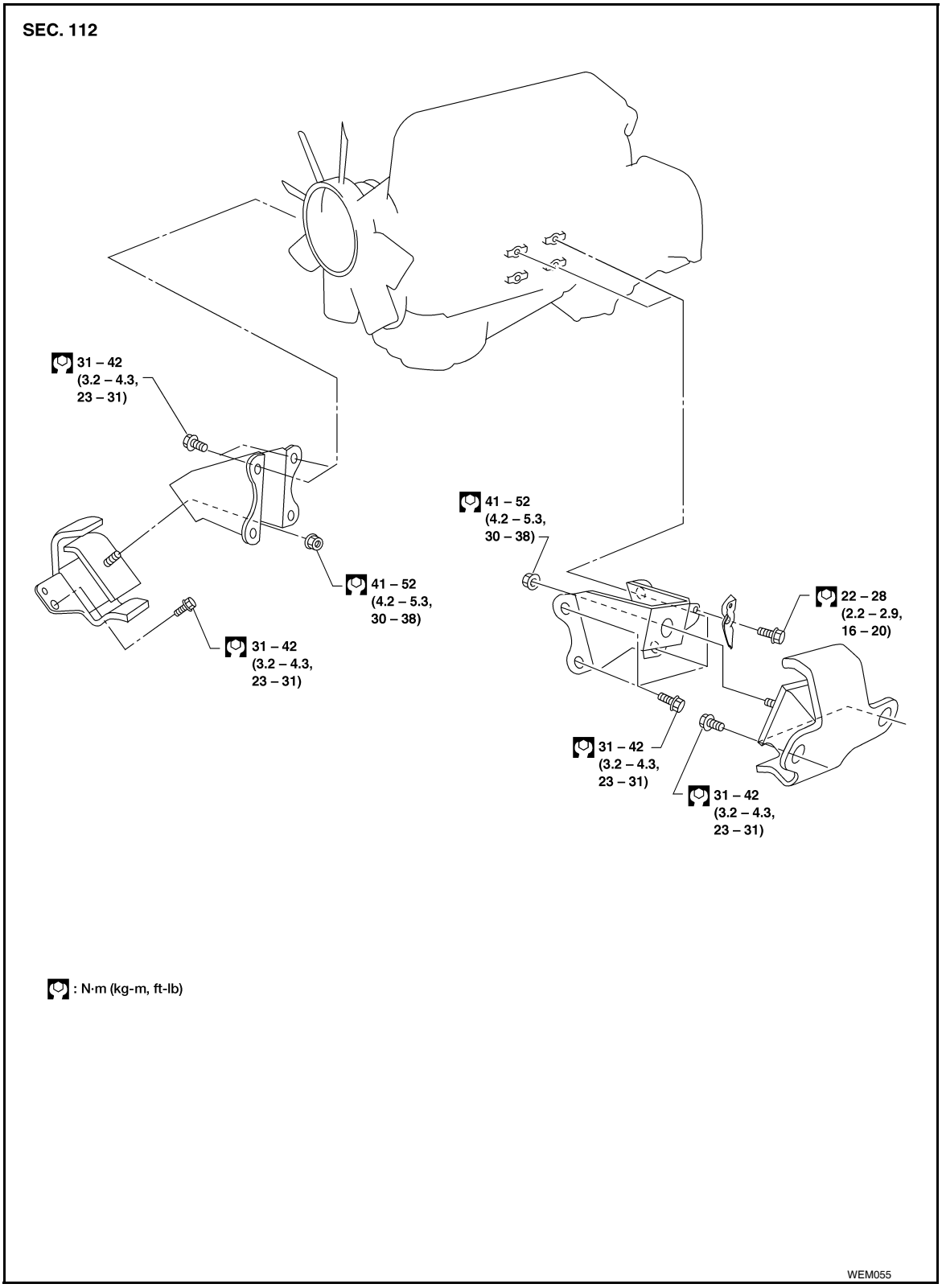


10. Place Tool (A) as described in steps 2 through 4.
11. Remove Tool (B).
12. Remove Tool (A).
13. Recheck the valve clearance.

ENGINE ASSEMBLY

Removal and Installation

INFOID:0000000006927472



WARNING:

- **Position vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.**
- **Before disconnecting fuel hose, release fuel pressure. Refer to EC-34, "Fuel Pressure Check".**

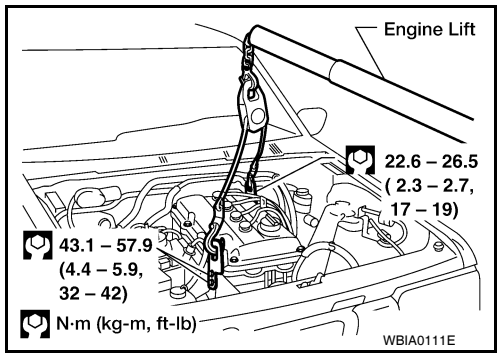
- **Be sure to hoist engine and transmission in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

- **When lifting engine, be sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **Before separating engine and transmission, remove the crankshaft position sensor (OBD) from the assembly.**
- **Always take extra care not to damage edge of crankshaft position sensor (OBD) or ring gear teeth.**

REMOVAL

1. Drain the coolant from engine block and radiator. Refer to CO-10, "Changing Engine Coolant".
2. Release the fuel pressure. Refer to EC-34, "Fuel Pressure Check".
3. Disconnect the fuel hose.
4. Remove the negative battery cable.
5. Remove the hood. Refer to BL-11, "Removal and Installation of Hood Assembly".
6. Remove the air cleaner. Refer to EM-17, "Removal and Installation".
7. Remove the power steering drive belt, generator drive belt and A/C compressor drive belt, if equipped. Refer to EM-16, "Removal and Installation".
8. Remove the radiator. Refer to CO-12, "Removal and Installation".
9. Remove the exhaust manifold heat shield. Refer to EM-12, "Removal and Installation".
10. Disconnect the exhaust system at rear of TWC (manifold).
11. Remove the A/C compressor from bracket, if equipped. Refer to MTC-68, "Removal and Installation for Compressor".
12. Disconnect the accelerator wire, vacuum hoses, electrical connectors, heater hoses and vacuum booster hose.
13. Remove the power steering pump, if equipped and position aside.
14. Remove the transmission. Refer to MT-12, "Removal and Installation".
15. Install the engine slingers and attach engine lift hooks as shown.
16. Remove the LH and RH engine mounts.
17. Lift and remove the engine.



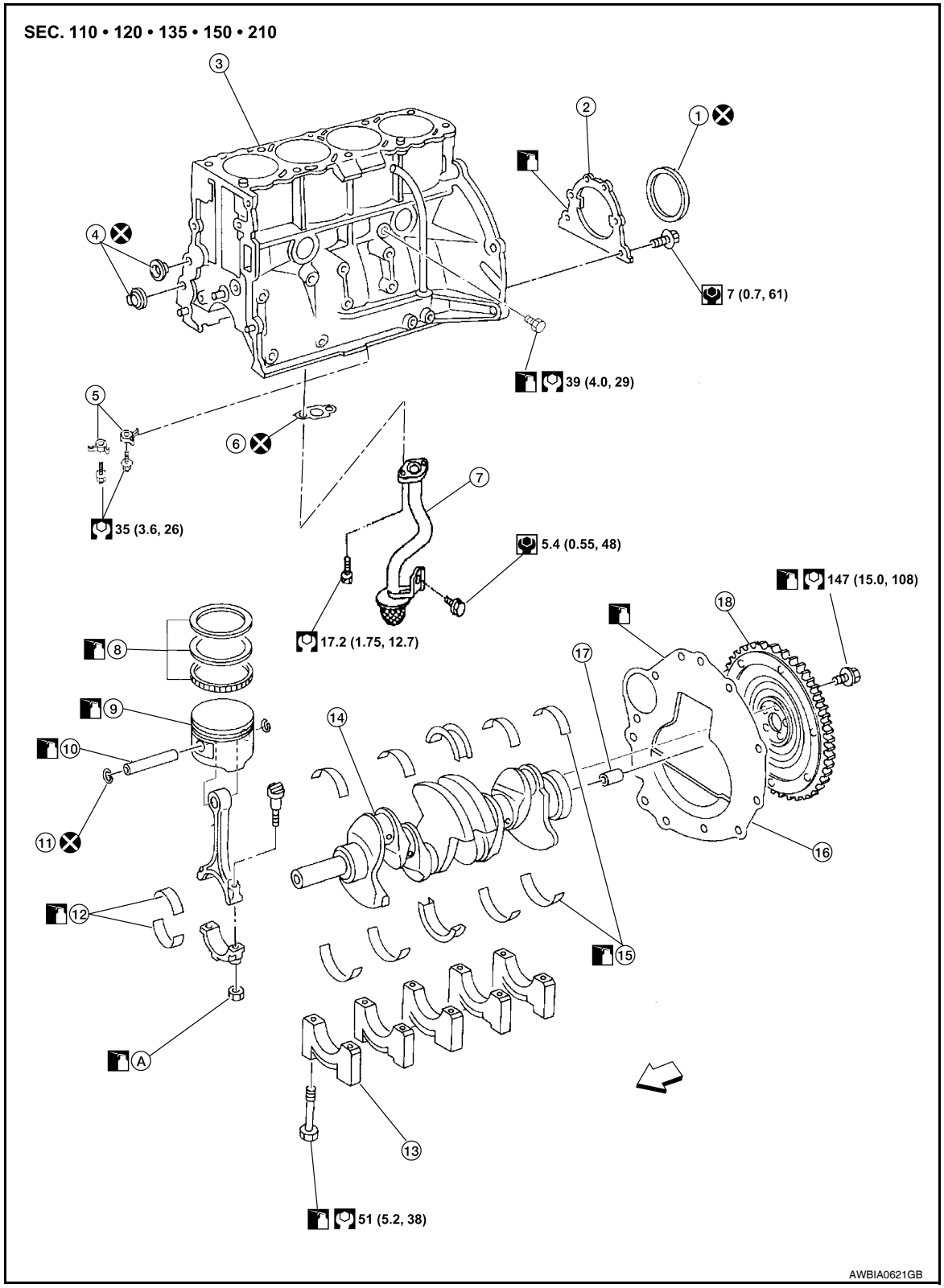
INSTALLATION

Installation is in the reverse order of removal.

CYLINDER BLOCK

Component

INFOID:0000000006927473



1. Rear oil seal
2. Rear oil seal retainer
3. Cylinder block
4. Oil seal
5. Oil jet
6. Gasket
7. Oil strainer
8. Piston rings
9. Piston

10. Piston pin
11. Snap ring
12. Connecting rod bearing
13. Main bearing cap
14. Crankshaft
15. Main bearing
16. Rear plate
17. Pilot bushing
18. Flywheel

A. 1st: 15 (1.5, 11)
2nd: 60 - 65 degrees

⇦ Front

Removal and Installation

INFOID:0000000006927474

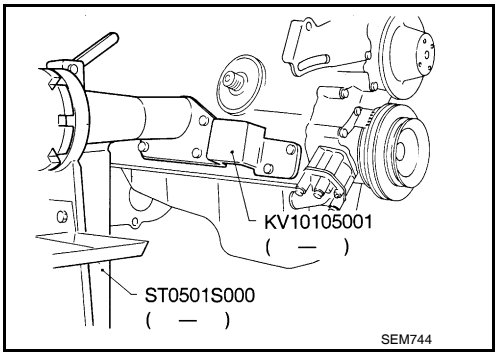
1. To remove the cylinder block for disassembly, remove the engine. Refer to EM-51, "Removal and Installation".
CAUTION:
- **When installing sliding parts, lubricate the contacting surfaces with new engine oil.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to the threads and seating surfaces.**
- **Do not allow any magnetic materials to contact the ring gear teeth of the flywheel.**
2. Installation is in the reverse order of removal.

Disassembly

INFOID:0000000006927475

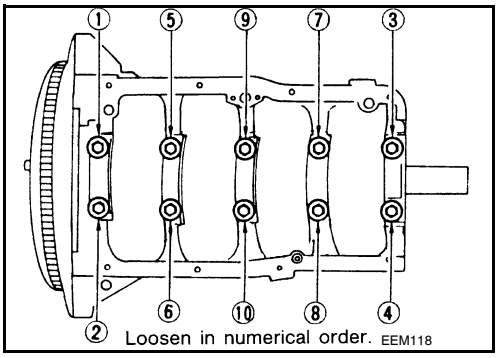
PISTON AND CRANKSHAFT

1. Place the engine on a work stand.
2. Remove the oil pan. Refer to EM-21, "Removal".
3. Remove the timing chain. Refer to EM-25, "Removal".
4. Remove the water pump. Refer to CO-17, "Removal".
5. Remove the cylinder head. Refer to EM-38, "Removal".
6. Remove the pistons with connecting rods.
CAUTION:
Use care not to scratch the engine block cylinder bore when removing the piston and connecting rod assemblies.



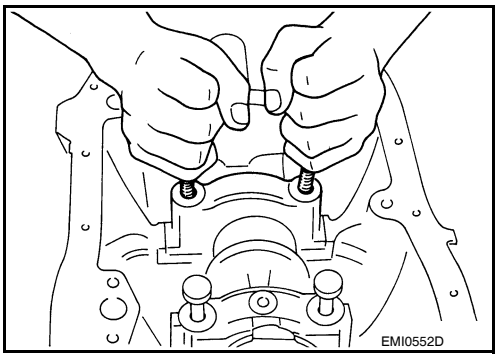
7. Remove bearing caps in the numerical order as shown, and remove the crankshaft.

a. Loosen the main bearing cap bolts in several steps in the numerical order as shown.
- Before removing the main bearing caps, mark the location and direction on each cap and bolt for correct placement for installation.
- Before removing the main bearing cap bolts, measure crankshaft end play. Refer to EM-55, "Inspection".



b. Using the main bearing cap bolts, remove the main bearing cap while shaking it right and left as shown.
- Remove the No. 3 and No. 5 main bearing caps using Tool.

Main Bearing Cap Remover : KV10114700 (J-38139)



8. Remove the crankshaft.

9. Remove the main bearings from the cylinder block journals and the main bearing caps.
CAUTION:
Before removal, mark the main bearings with their location and direction for installation into their original position.
10. Remove the oil jets.

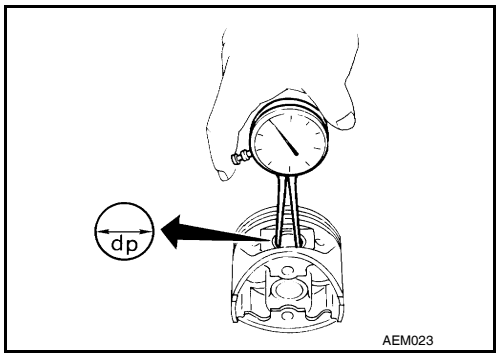
Inspection

INFOID:0000000006927476

PISTON AND PISTON PIN CLEARANCE

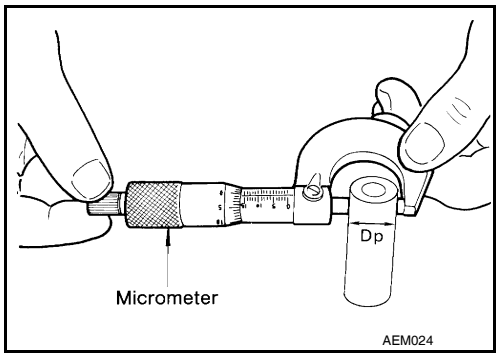
1. Measure the inner diameter of piston pin hole “dp”.

Standard diameter “dp” : 20.993 - 21.005 mm (0.8265 - 0.8270 in)



2. Measure the outer diameter of piston pin “Dp”.

Standard diameter “Dp” : 20.989 - 21.001 mm (0.8263 - 0.8268 in)



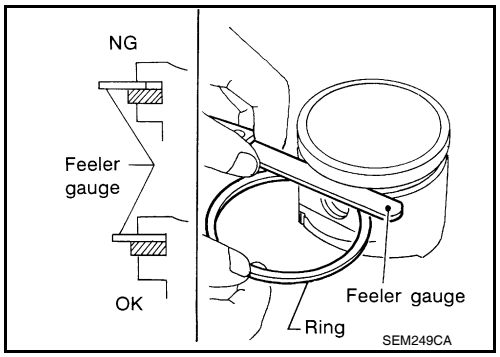
3. Calculate the piston pin clearance.

Piston pin clearance : dp – Dp = (–0.002) - 0.006 mm [(–0.0001) - 0.0002 in]

If it exceeds the above value, replace piston and pin assembly.

PISTON RING SIDE CLEARANCE

Measure the piston ring side clearance as shown. If the clearance exceeds the specification, replace piston ring.
If the clearance exceeds the maximum side clearance limit with the new piston ring, replace piston.

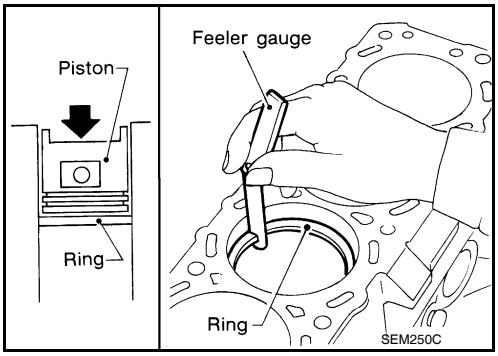


Side Clearance

Top ring	**: 0.04 - 0.08 mm (0.0016 - 0.0031 in)**
2nd ring	**: 0.03 - 0.07 mm (0.0012 - 0.0028 in)**
Oil ring	**: 0.065 - 0.135 mm (0.0026 - 0.0053 in)**
Limit (Top, 2nd)	**: 0.1 mm (0.004 in)**

PISTON RING END GAP

1. Measure the piston ring end gap as shown. If out of specification, replace piston ring. If gap exceeds maximum limit with a new ring, replace cylinder block. Refer to EM-73, "Piston, Piston Ring and Piston pin".



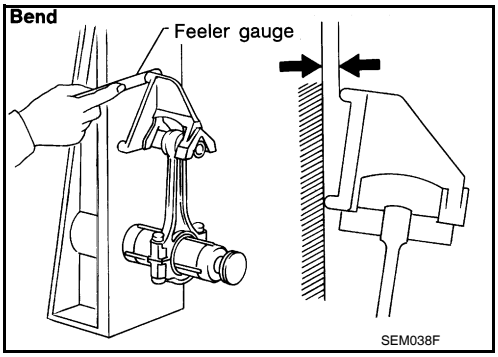
2. When replacing the piston, check cylinder block surface for scratches or seizure. If scratches or seizure are found, hone or replace the cylinder block.

Piston Ring End Gap

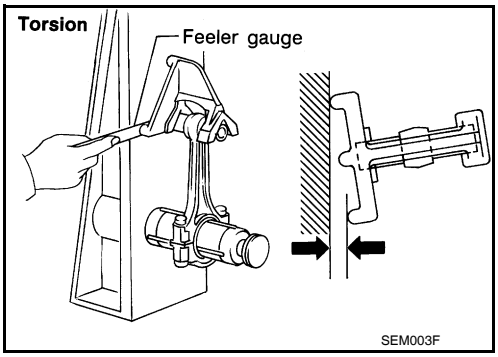
Top ring	**: 0.28 - 0.52 mm (0.0110 - 0.0205 in)**
2nd ring	**: 0.45 - 0.69 mm (0.0177 - 0.0272 in)**
Oil ring (rail ring)	**: 0.20 - 0.69 mm (0.0079 - 0.0272 in)**
Limit	**: 1.0 mm (0.039 in)**

CONNECTING ROD BEND AND TORSION

Measure the connecting rod bend and torsion as shown.
If either of the measurements exceed the limits, replace the connecting rod assembly.



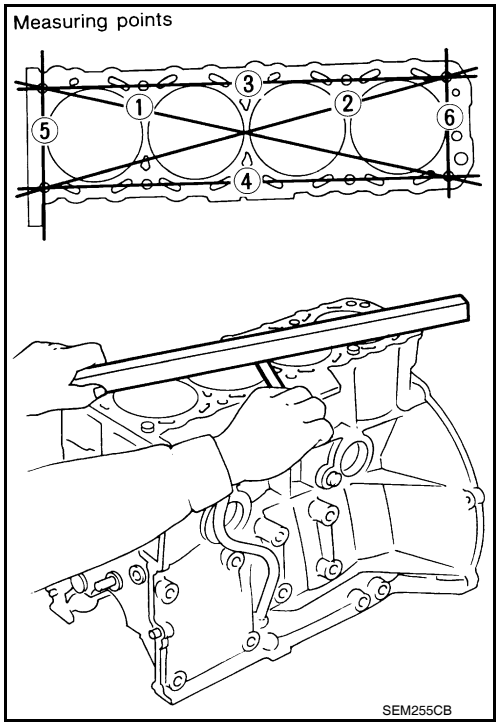
Bend limit	**: 0.15 mm (0.0059 in) per 100 mm (3.94 in) length**
Torsion limit	**: 0.30 mm (0.0118 in) per 100 mm (3.94 in) length**



CYLINDER BLOCK DISTORTION AND WEAR

1. Clean upper face of cylinder block.

2. Use a reliable straightedge and feeler gauge to check the flatness of the cylinder block upper face surface. Check along the six positions as shown.



Cylinder block distortion

Standard	**: —**
Limit	**: 0.1 mm (0.004 in)**

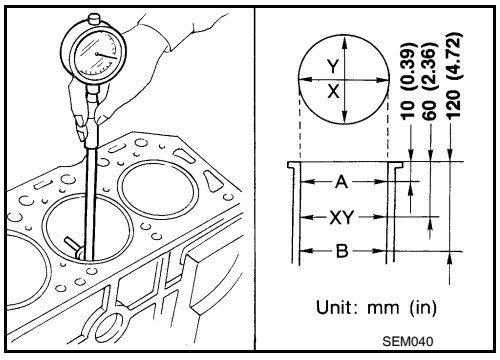
3. If the block distortion exceeds specification, resurface the block. Replace the block if necessary.
The limit for cylinder block resurfacing is determined by cylinder head resurfacing.
Amount of cylinder head resurfacing is "A"
Amount of cylinder block resurfacing is "B"

The maximum limit is as follows	**: A + B = 0.2 mm (0.008 in)**
Nominal block height at crankshaft center	**: 246.95 - 247.05 mm (9.7224 - 9.7264 in)**
Max. block distortion limit = A + B	**: 0.2 mm (0.008 in)**

4. If necessary, replace cylinder block.

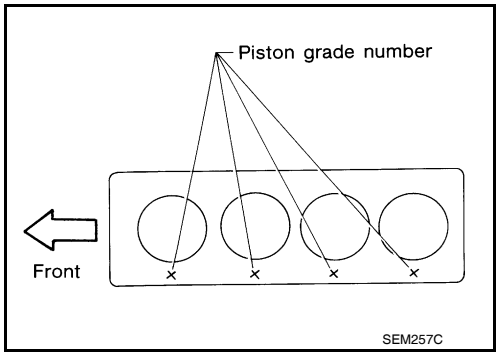
PISTON-TO-CYLINDER BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

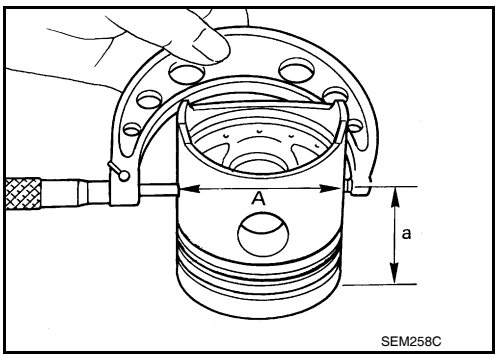


Standard inner diameter	**: Refer to EM-72, "Cylinder Block".**
Out-of-round (X – Y) standard	**: 0.015 mm (0.0006 in)**
Taper (A – B) standard	**: 0.010 mm (0.0004 in)**
Wear limit	**: 0.2 mm (0.008 in)**

2. Check for scratches and seizure. If seizure is found, hone it.
CAUTION:
If the cylinder block and pistons are replaced, match the piston grade with the grade number on the cylinder block upper surface as shown. Refer to EM-73, "Piston, Piston Ring and Piston pin".



3. Measure piston skirt diameter.



Piston diameter "A" : refer to EM-73, "Piston, Piston Ring and Piston pin".

Measuring point "A" at height "a" from the top : approximately 48 mm (1.89 in)

4. Check that piston-to-cylinder bore clearance is within specification.

Piston-to-cylinder bore clearance "B" : 0.020 - 0.040 mm (0.0008 - 0.0016 in)

5. Cylinder rebore diameter "D" is determined by adding piston-to-cylinder bore clearance "B" to the piston diameter "A" and subtracting the honing allowance "C".

Rebore size calculation: D = A + B - C

Where,

D : rebore diameter

A : piston diameter as measured

B : piston-to-cylinder bore clearance

C : honing allowance of 0.02 mm (0.0008 in)

6. Install the main bearing caps and tighten the cap bolts to specification. This will prevent distortion of the cylinder bores during the honing process.

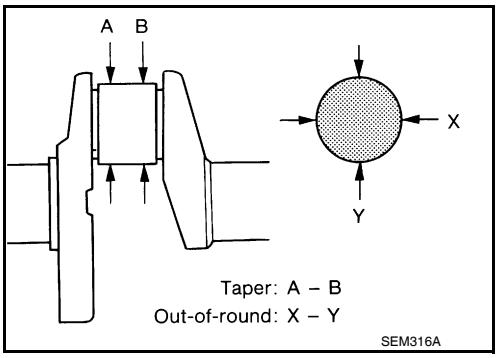
Main bearing cap bolts : 51 N·m (5.2 kg-m, 38 ft-lb)

7. Hone the cylinder bores to obtain the specified piston-to-cylinder bore clearance.
CAUTION:
- **When any cylinder needs boring, all other cylinders must also be bored.**
- **Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so at a time.**

8. Measure finished cylinder bore for out-of-round and taper.
CAUTION:
- **Measurement should be done after cylinder bore cools down.**

CRANKSHAFT

1. Check the crankshaft main and pin journals for scratches, wear, or cracks.
2. With a micrometer, measure the journals for taper and out-of-round.



Out-of-round (X – Y)

Main journal : **less than 0.01 mm (0.0004 in)**

Crankshaft pin : **less than 0.005 mm (0.0002 in)**

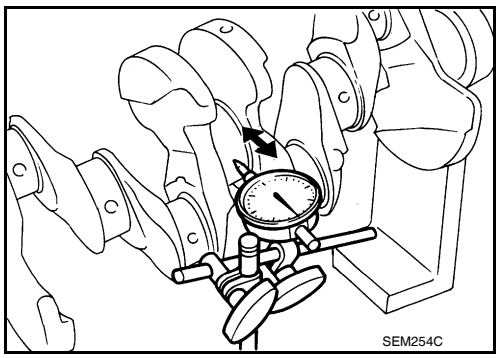
Taper (A – B)

Main journal : **less than 0.01 mm (0.0004 in)**

Crankshaft pin : **less than 0.005 mm (0.0002 in)**

3. Measure the crankshaft runout.

Runout (total indicator reading) : less than 0.10 mm (0.0039 in)



4. If the crankshaft is out of specification, replace the crankshaft.

BEARING CLEARANCE

Method A (using a bore gauge and micrometer)

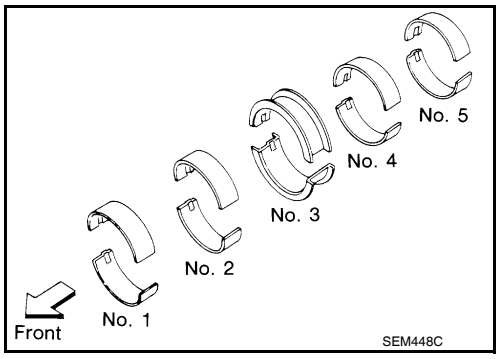
Use Method A or Method B. Method A is preferred because it is more accurate.

NOTE:

Use the following procedures to inspect the bearing clearance using Method A (bore gauge and micrometer).

Main bearing

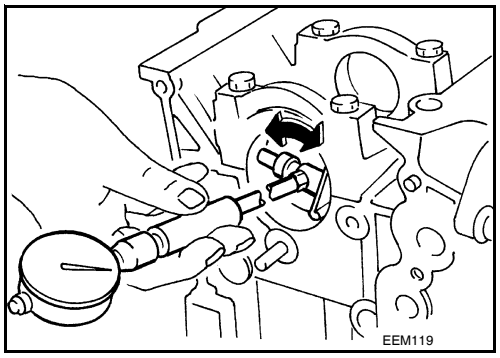
1. Set main bearings in their proper positions on the cylinder block and main bearing caps. Follow the position numbering as shown.



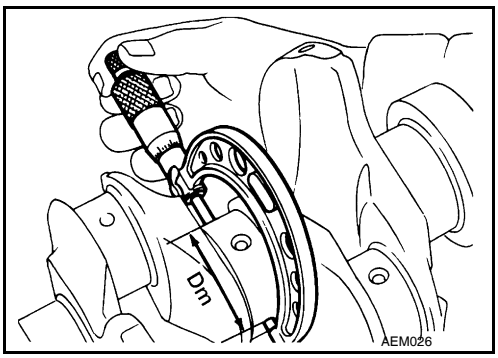
2. Install the main bearing caps on the cylinder block.
   - Tighten the main bearing cap bolts in two or three steps to specification.

Main bearing cap bolts : 51 N·m (5.2 kg-m, 38 ft-lb)

3. Measure the inner diameter “A” of each main bearing as shown.



4. Measure the outer diameter “Dm” of each crankshaft main journal as shown.



5. Calculate the main bearing clearance.

Main bearing clearance = A – Dm

Standard : 0.020 - 0.047 mm (0.0008 - 0.0019 in)

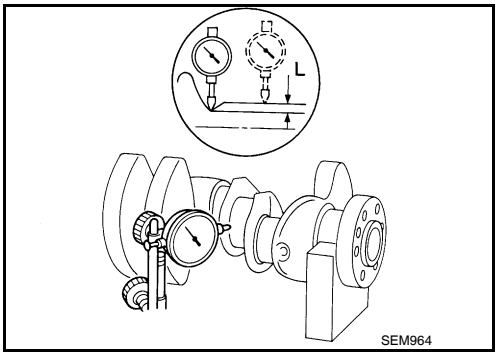
Limit : 0.1 mm (0.004 in)

If the main bearing clearance exceeds the limit, replace the bearing.

6. If the clearance cannot be adjusted within the standard of any bearing, grind the crankshaft journals and use an undersized replacement bearing as follows.

a. When grinding the crankshaft journals, confirm that the “L” dimension in fillet roll is more than the specified limit.

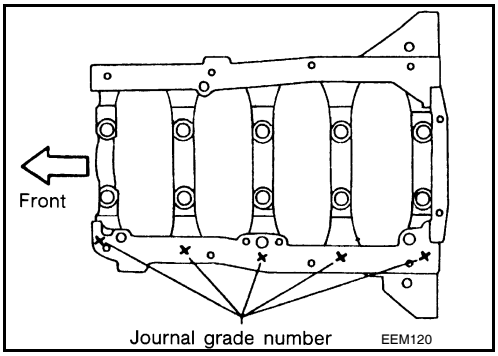
“L” : 0.1 mm (0.004 in)



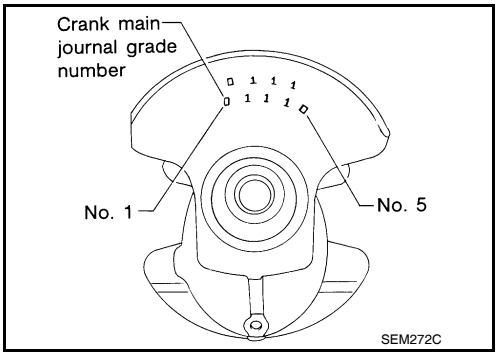
b. Grind the crankshaft to use it with replacement parts. Refer to EM-75, "Crankshaft", and EM-76, "Available Main Bearing".

7. If the crankshaft is reused, measure the main bearing clearance and select the thickness of the main bearing.
If the crankshaft or cylinder block is replaced, select the thickness of the main bearings as follows.

a. The grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



b. The grade number of each crankshaft main journal is punched on crankshaft. These numbers are punched in either Arabic or Roman numerals.



c. Select the main bearing with a suitable thickness according to the following example and table.
Example:

Main journal grade number is 1or I
Crankshaft journal grade number is 2 or II
Main bearing grade number = 1 + 2 = 3 (Yellow)

Main Bearing Grade Number and Identification Color

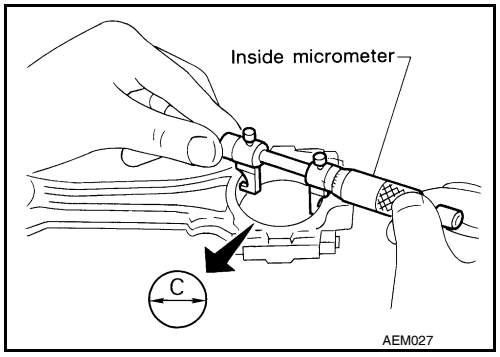
		Main journal grade number		
		0	1 or I	2 or II
Crankshaft journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1 or I	1 (Brown)	2 (Green)	3 (Yellow)
	2 or II	2 (Green)	3 (Yellow)	4 (Blue)

Connecting Rod Bearing (Big End)

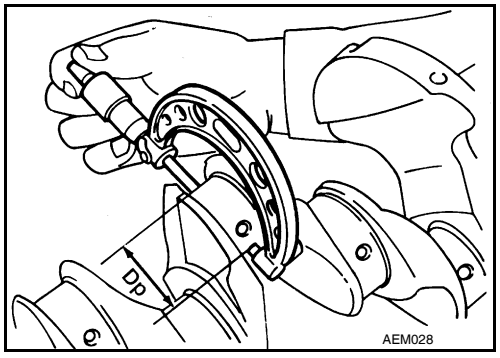
1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.
   • **Tighten the connecting rod cap bolts in two stages to specification.**

Connecting rod cap bolts
Stage 1 : 15 N·m (1.5 kg-m, 11 ft-lb)
Stage 2 : 60° - 65° degrees

3. Measure inner diameter “C” of each bearing.



4. Measure outer diameter “Dp” of each crankshaft pin journal.



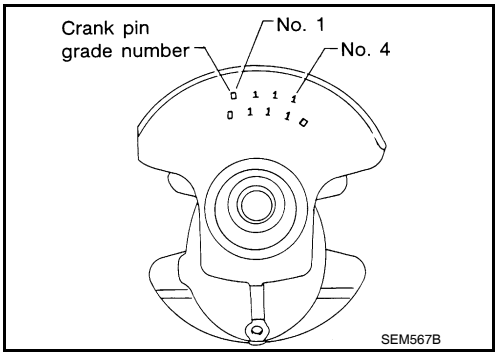
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C – Dp
Standard : 0.010 - 0.035 mm (0.0004 - 0.0014 in)
Limit : 0.09 mm (0.0035 in)

If the clearance exceeds the limit, replace the bearing.

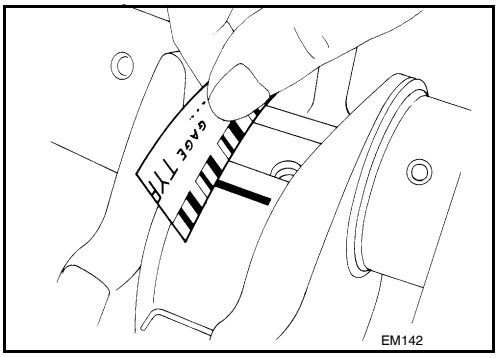
6. If the clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to EM-76, "Available Connecting Rod Bearing".

7. If the crankshaft is replaced, select the connecting rod bearing according to the following table.
NOTE:
The grade number of each crankshaft pin are punched on the crankshaft as shown. These grade numbers are in either Arabic or Roman numerals.



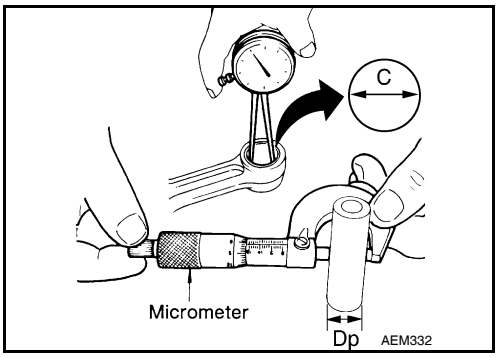
Crankshaft pin grade number	Connecting rod bearing grade number
0	0
1 or I	1
2 or II	2

Method B (using a plastigage)
Measure the bearing clearances using the plastigage.
CAUTION:
- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or under-sized bearing so that the specified bearing clearance is obtained.**



CONNECTING ROD BUSHING CLEARANCE (SMALL END)

1. Measure inner diameter “C” of bushing.
2. Measure outer diameter “Dp” of piston pin.



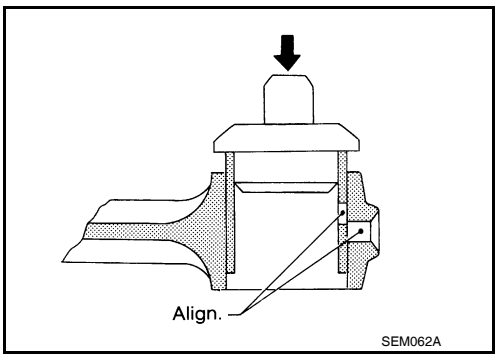
3. Calculate connecting rod bushing clearance.

Connecting rod bushing clearance = C – Dp
Standard : 0.005 - 0.017 mm (0.0002 - 0.0007 in)
Limit : 0.023 mm (0.0009 in)

If the calculated clearance is out of specification, replace the connecting rod assembly or the piston set with pin, or both as necessary.

REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

1. Drive in the small end bushing until it is flush with the rod end surface.
CAUTION:
Align the oil holes before installing for lubrication.



2. Ream the bushing until clearance with piston pin is within specification.

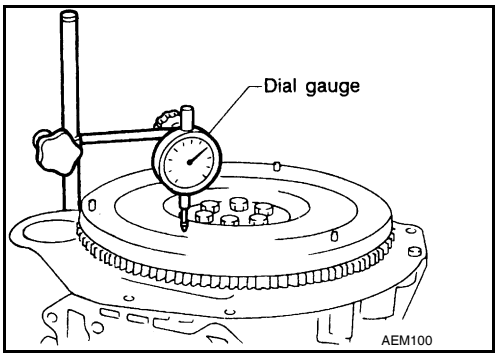
Connecting rod bushing clearance : 0.005 - 0.017 mm (0.0002 - 0.0007 in)

FLYWHEEL

Using a dial gauge, rotate the flywheel and measure the runout by the total dial gauge indicator reading as shown

Runout (total indicator reading) : less than 0.15 mm (0.006 in)

CAUTION:
- **Be careful not to damage the ring gear teeth.**
- **Do not allow any magnetic materials to contact the ring gear teeth.**
- **Do not resurface the flywheel. Replace as necessary.**

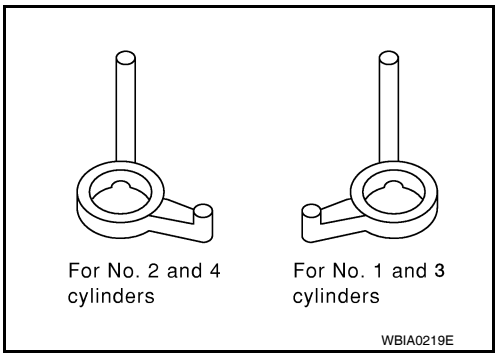


Assembly

INFOID:0000000006927477

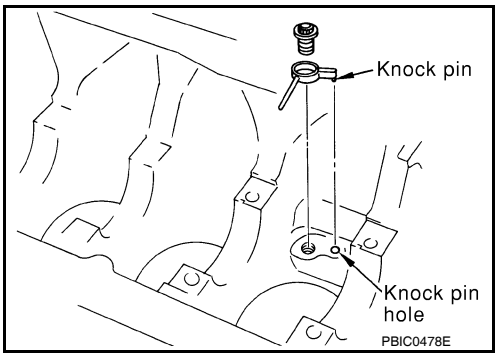
PISTON

1. Completely remove any foreign material from the cylinder block, inside the crankshaft case, and cylinder bores by blowing compressed air in the passages and oil passages.
2. Install the oil jets.
   - Oil jets for the No. 1 and No. 3 cylinders are a different shape from those for the No. 2 and No. 4 cylinders, as shown.

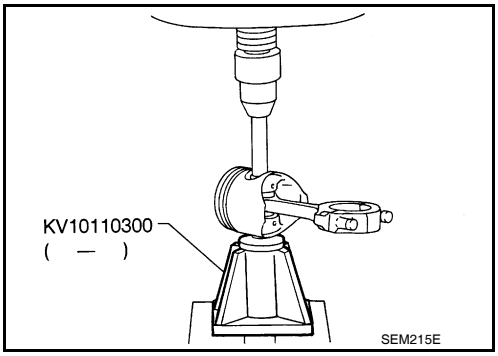


   - Insert the oil jet knock pin into the cylinder block knock pin hole, and tighten the knock pin bolt to specification.

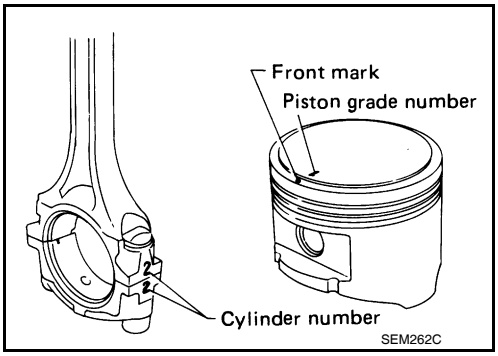
Oil jet bolt : 35 N·m (3.6 kg-m, 26 ft-lb)



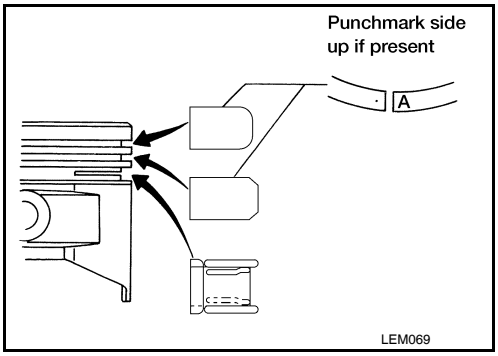
3. Heat piston to 60° to 70°C (140° to 158°F) and assemble piston, piston pin and connecting rod.
   - Align the direction of piston and connecting rod.



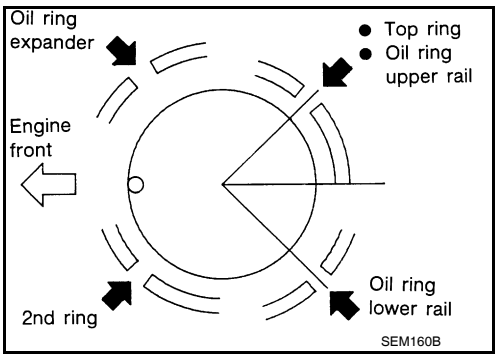
   - Numbers stamped on connecting rod and cap correspond to each cylinder.
   - After assembly, make sure connecting rod swings smoothly.



4. Set piston rings as shown.
   CAUTION:
   - **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
   - **When piston rings are being replaced and no punchmark is present, piston rings can be mounted with either side up.**

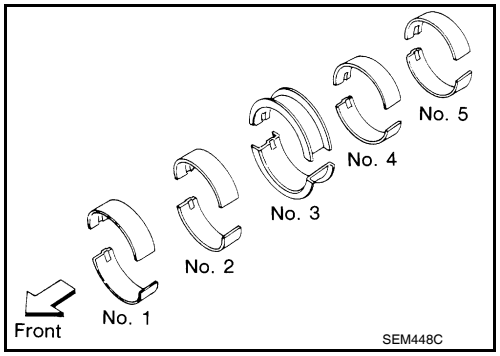


5. Align piston rings so that end gaps are positioned as shown.



CRANKSHAFT

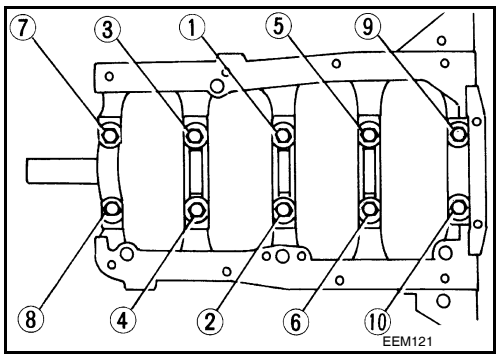
1. Set the main bearings in their proper positions on the cylinder block and main bearing caps as shown.
   - **Confirm that correct main bearings are used. Refer to EM-55, "Inspection".**
   - **Apply new engine oil to bearing surfaces.**



2. Install the crankshaft and main bearing caps and tighten the bolts in numerical order as shown, to specification.
   - Apply new engine oil to the bolt threads and seat surface.
   - Prior to tightening the bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.
   - Tighten the bearing cap bolts gradually in two or three stages to specification. Tighten the bearing cap bolts in the numerical order as shown.

   Main bearing cap bolts : 51 N·m (5.2 kg-m, 38 ft-lb)

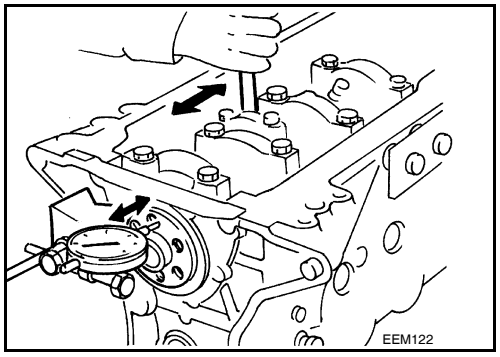
   - After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.



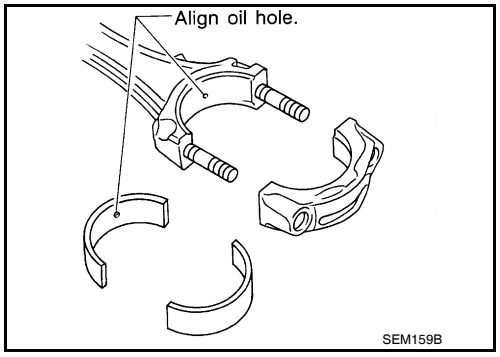
3. Measure the crankshaft end play as shown.

   Crankshaft end play
   Standard : 0.05 - 0.18 mm (0.0020 - 0.0071 in)
   Limit : 0.3 mm (0.012 in)

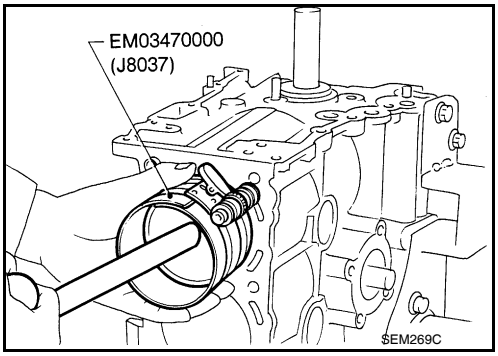
   If beyond the limit, replace No. 3 bearing with a new one.



4. Install connecting rod bearings in connecting rods and connecting rod caps.
   - Confirm that correct bearings are used. Refer to EM-55, "Inspection".
   - Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
   - Apply new engine oil to bearing surfaces, bolt threads and seating surfaces.

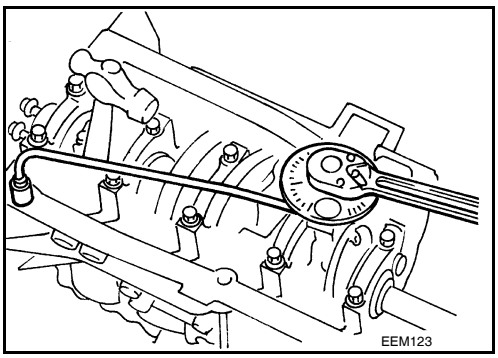


5. Install the piston assemblies into the corresponding cylinder bores using Tool as shown.
   - Position the piston assembly so that the front mark on the piston head faces toward the front of the engine.
   - Make sure the connecting rod does not scratch the cylinder wall.
   - Make sure the connecting rod bolts do not scratch the crankshaft journals.
   - Apply new engine oil to the piston rings and sliding surface of piston.



6. Install the connecting rod bearing caps. If reusing the connecting rod bearing caps, they must be installed in their original position and direction.
   Tighten the connecting rod bearing cap nuts in two steps to specification. For step 2 use a suitable angle wrench, or tighten to specification if an angle wrench is not available.

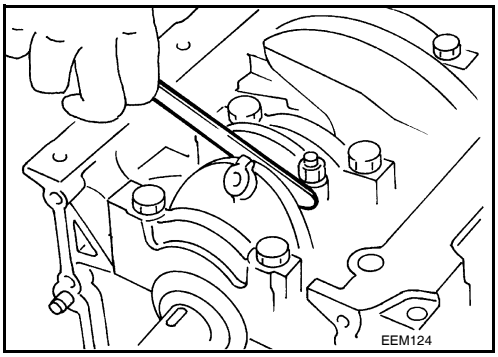
   Connecting rod bearing nuts, tighten in two steps:
   Step 1 : 15 N·m (1.5 kg-m, 11 ft-lb).
   Step 2 : 60° to 65° degrees clockwise



7. Measure the connecting rod side clearance.

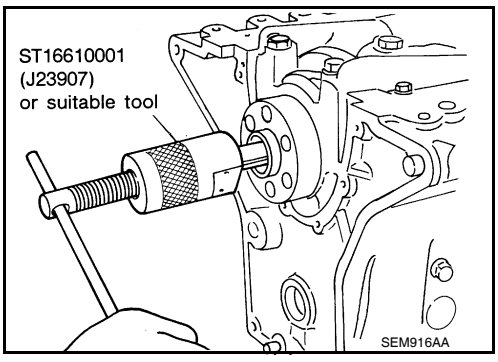
   Connecting rod side clearance
   Standard : 0.2 - 0.4 mm (0.008 - 0.016 in)
   Limit : 0.6 mm (0.024 in)

   If the clearance is beyond the limit, replace either the connecting rod or crankshaft, or both, as necessary.



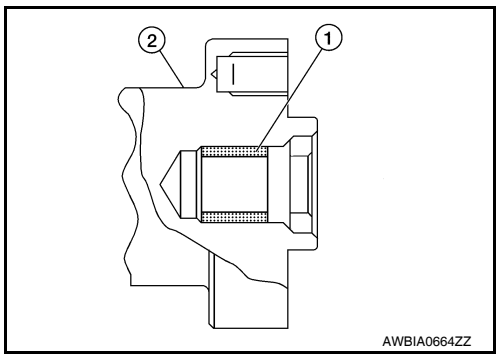
REPLACING PILOT BUSHING

1. Remove the pilot bushing using Tool as shown.



2. Install the pilot bushing (1) as shown.

(2) : Crankshaft



SERVICE DATA AND SPECIFICATIONS (SDS)

General Specification

INFOID:0000000006927478

Cylinder arrangement		In-line 4
Displacement		2,389 cm^3 (145.78 cu in)
Bore and stroke		89 x 96 mm (3.50 x 3.78 in)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		9.2

COMPRESSION PRESSURE

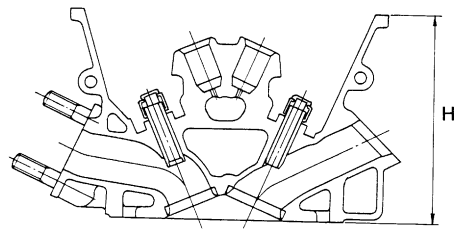
Unit: kPa (kg/cm^2, psi)/300 rpm

Standard	1,226 (12.5, 178)
Minimum	1,030 (10.5, 149)
Differential limit between cylinders	98 (1.0, 14)

Cylinder Head

INFOID:0000000006927479

Unit: mm (in)



Nominal cylinder head height:
H = 126.3 - 126.5 (4.972 - 4.980)

SEM519E

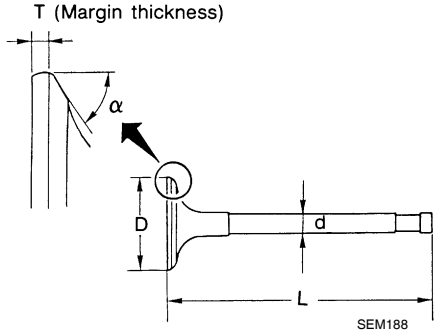
	Limit
Cylinder head surface distortion	0.1 (0.004)

Valve

INFOID:0000000006927480

VALVE

Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	36.5 - 36.7 (1.437 - 1.445)

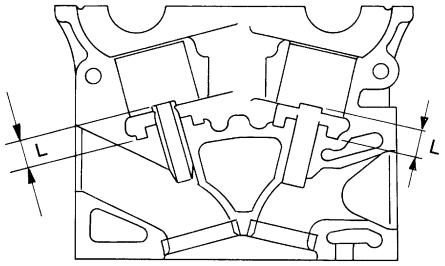
	Exhaust	31.2 - 31.4 (1.228 - 1.236)
Valve length “L”	Intake	101.17 - 101.47 (3.9831 - 3.9949)
	Exhaust	98.67 - 98.97 (3.8846 - 3.8964)
Valve stem diameter “d”	Intake	6.965 - 6.980 (0.2742 - 0.2748)
	Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle “α”	Intake & Exhaust	45°15′ - 45°45′
Valve margin “T”	Intake	0.95 - 1.25 (0.0374 - 0.0492)
	Exhaust	1.15 - 1.45 (0.0453 - 0.0571)
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE SPRING

Free height mm (in)		50.3 (1.9831)
Pressure N (kg, lb) at height mm (in)	Standard	418.0 (42.6, 93.9) at 29.17 (1.1484)
	Limit	393.0 (40.1, 88.4) at 29.17 (1.1484)
Out-of-square mm (in)		Less than 2.2 (0.087)

VALVE GUIDE

Unit: mm (in)



SEM301D

		Standard	Service
Valve guide Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	7.000 - 7.018 (0.2756 - 0.2763)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.2 (0.008)	
Projection length “L”		13.3 - 13.9 (0.524 - 0.547)	

VALVE LIFTER

Unit: mm (in)

Valve lifter outer diameter	33.960 - 33.975 (1.3370 - 1.3376)

Lifter guide inner diameter	34.000 - 34.021 (1.3386 - 1.3394)
Clearance between lifter and filter guide	0.025 - 0.061 (0.0010 - 0.0024)

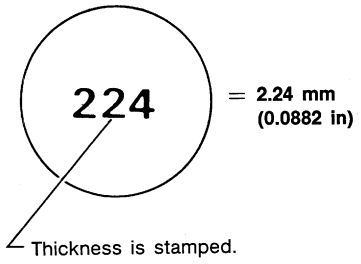
VALVE CLEARANCE ADJUSTMENT

Unit: mm (in)

Valve clearance (Hot)	Intake	0.31 - 0.39 (0.012 - 0.015)
	Exhaust	0.39 - 0.47 (0.015 - 0.019)

AVAILABLE SHIMS

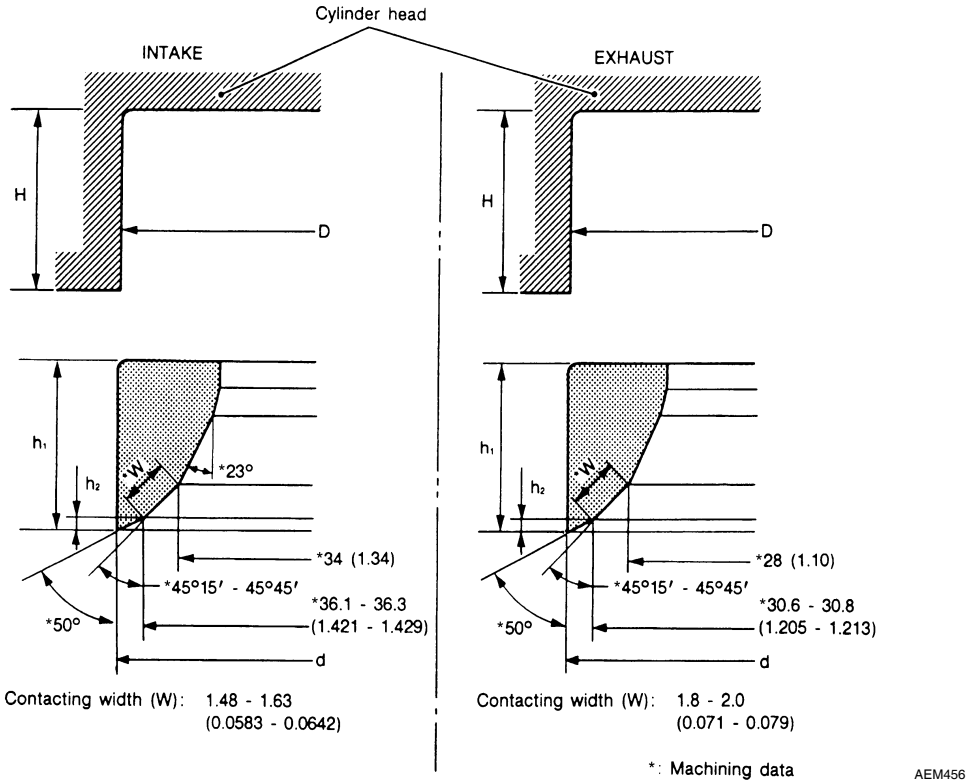
Thickness mm (in)	Identification mark*	Thickness mm (in)	Identification mark*
—	—	1.90 (0.0748)	190
1.92 (0.0756)	192	1.94 (0.0764)	194
1.96 (0.0772)	196	1.98 (0.0780)	198
2.00 (0.0787)	200	2.02 (0.0795)	202
2.04 (0.0803)	204	2.06 (0.0811)	206
2.08 (0.819)	208	2.10 (0.0827)	210
2.12 (0.0835)	212	2.14 (0.0843)	214
2.16 (0.0850)	216	2.18 (0.0858)	218
2.20 (0.0866)	220	2.22 (0.0874)	222
2.24 (0.0882)	224	2.26 (0.0890)	226
2.28 (0.0898)	228	2.30 (0.0906)	230
2.32 (0.0913)	232	2.34 (0.0921)	234
2.36 (0.0929)	236	2.38 (0.0937)	238
2.40 (0.0945)	240	2.42 (0.0953)	242
2.44 (0.0961)	244	2.46 (0.0969)	246
2.48 (0.0976)	248	2.50 (0.0984)	250
2.52 (0.0992)	252	2.54 (0.1000)	254
2.56 (0.1008)	256	2.58 (0.1016)	258
2.60 (0.1024)	260	2.62 (0.1031)	262
2.64 (0.1039)	264	2.66 (0.1047)	266
2.68 (0.1055	268	—	—

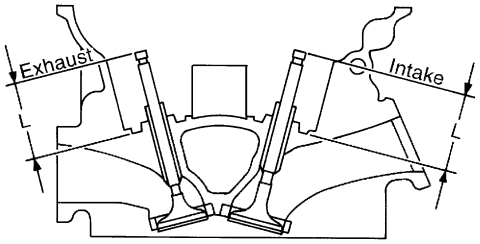


*: Always check with the Parts Department for the latest parts information

VALVE SEAT

Unit: mm (in)





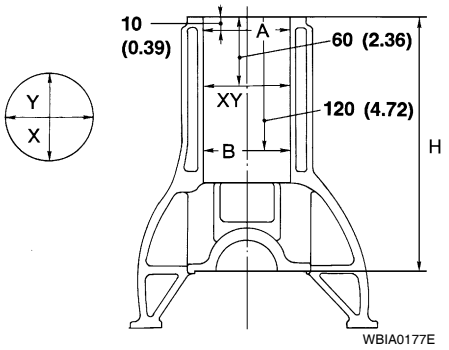
		Standard	Service
Cylinder head seat recess diameter (D)	Intake	37.500 - 37.516 (1.4764 - 1.4770)	38.000 - 38.016 (1.4961 - 1.4967)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.064 - 0.096 (0.0025 - 0.0038)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	37.580 - 37.596 (1.4795 - 1.4802)	38.080 - 38.096 (1.4992 - 1.4998)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Depth (H)	Intake	6.1 - 6.3 (0.240 - 0.248)	
	Exhaust	6.1 - 6.3 (0.240 - 0.248)	
Height (h_1)	Intake	5.8 - 6.0 (0.228 - 0.236) 5.9 - 6.0 (0.232 - 0.236)	5.3 - 5.5 (0.209 - 0.217)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	5.32 - 5.42 (0.209 - 0.213)
Height (h_2)	Intake	0.24 - 0.64 (0.0094 - 0.0252) 0.34 - 0.64 (0.0134 - 0.0252)	
	Exhaust	0.43 - 0.73 (0.0169 - 0.0287)	

Valve seat resurface limit (L)	Intake	42.02 - 42.52 (1.6543 - 1.6740)
	Exhaust	42.03 - 42.53 (1.6547 - 1.6744)

Cylinder Block

INFOID:0000000006927481

Unit: mm (in)



			Standard	Limit
Distortion			—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)*
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X – Y)		Less than 0.015 (0.0006)	—
	Taper (A – B)		Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders			Less than 0.03 (0.0012)	0.2 (0.008)
Piston-to-cylinder bore clearance			0.020 - 0.040 (0.0008 - 0.0016)	—
Cylinder block height (From crankshaft center)			246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)**

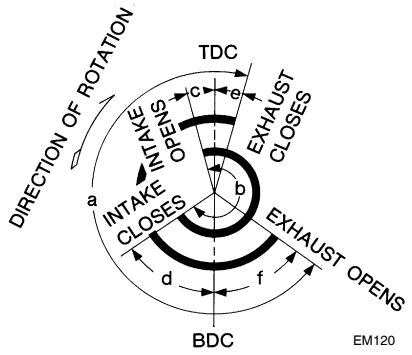
* Wear limit

** Total amount of cylinder head resurfacing and cylinder block resurfacing

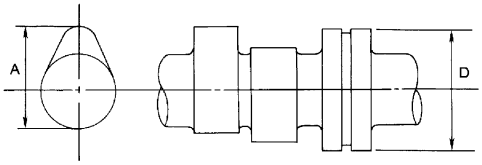
Camshaft and Camshaft Bearing

INFOID:0000000006927482

Unit: mm (in)



EM120



WBIA0176E

		Standard	Limit
Cam height (A)	Intake	41.755 - 41.945 (1.644 - 1.651)	—
	Exhaust	41.815 - 42.005 (1.646 - 1.654)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	#1 to #5 journals	28.000 - 28.025 (1.1024 - 1.1033)	—
Outer diameter of camshaft journal (D)	#1 to #5 journals	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	224	—
	b	224	—
	c	−1	—
	d	45	—
	e	7	—
	f	37	—

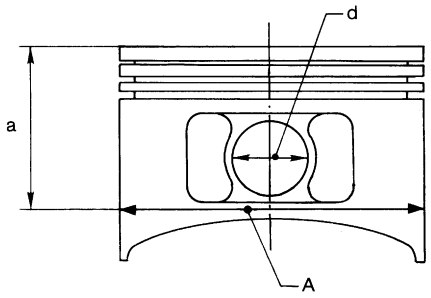
* Total indicator reading

Piston, Piston Ring and Piston pin

INFOID:0000000006927483

PISTON

Unit: mm (in)



SEM804E

		Grade*	Dimension
Piston skirt diameter "A"	Standard	Grade No. 1	88.970 - 88.980 (3.5027 - 3.5031)
		Grade No. 2	88.980 - 88.990 (3.5031 - 3.5035)
		Grade No. 3	88.990 - 89.000 (3.5035 - 3.5039)
Height "a"		Approximately 48 (1.89)	
Piston pin hole diameter "d"		20.993 - 21.005 (0.8265 - 0.8270)	
Piston-to-cylinder bore clearance		0.020 - 0.040 (0.0008 - 0.0016)	

*: Always check with the Parts Department for the latest parts information

PISTON PIN

Unit: mm (in)

	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	−0.002 to 0.006 (−0.0001 to 0.0002)	—
Connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

PISTON RING

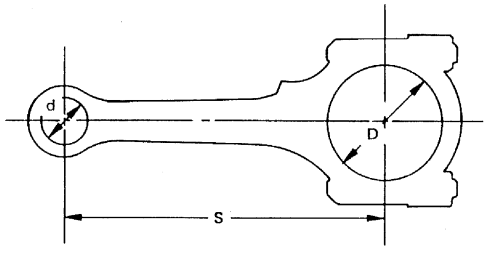
Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.1 (0.004)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
	Oil	0.065 - 0.135 (0.0026 - 0.0053)	—
Ring gap	Top	0.28 - 0.52 (0.0110 - 0.0205)	1.0 (0.039)
	2nd	0.45 - 0.69 (0.0177 - 0.0272)	1.0 (0.039)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	1.0 (0.039)

Connecting Rod

INFOID:0000000006927484

Unit: mm (in)



WBIA0178E

	Standard	Limit

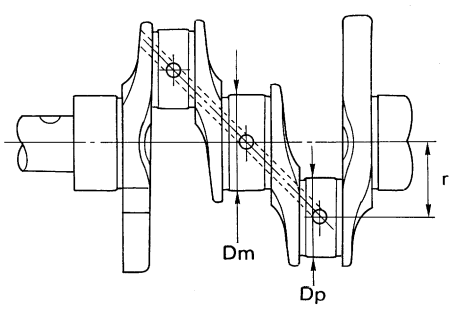
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Connecting rod small end inner diameter (d)*	23.970 - 24.000 (0.9437 - 0.9449)	—
Piston pin bushing inner diameter	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866 - 2.0871)	—
Side clearance	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)

* Without bearing

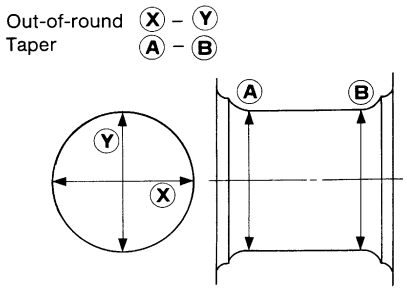
Crankshaft

INFOID:0000000006927485

Unit: mm (in)



SEM394



EM715

	Grade[1]	Dimension	
Main journal diameter (Dm)	Grade No. 0	59.967 - 59.975 (2.3609 - 2.3612)	
	Grade No. 1	59.959 - 59.967 (2.3606 - 2.3609)	
	Grade No. 2	59.951 - 59.959 (2.3603 - 2.3606)	
Pin journal diameter (Dp)	Grade No. 0	49.968 - 49.974 (1.9672 - 1.9675)	
	Grade No. 1	49.962 - 49.968 (1.9670 - 1.9672)	
	Grade No. 2	49.956 - 49.962 (1.9668 - 1.9670)	
Center distance (r)		47.95 - 48.05 (1.8878 - 1.8917)	
		Standard	Limit
Taper of journal and pin [A - B]	Journal	—	0.01 (0.0004)
	Pin	—	0.005 (0.0002)
Out-of-round of journal and pin [X - Y]	Journal	—	0.01 (0.0004)
	Pin	—	0.005 (0.0002)
Runout [TIR][2]		—	0.10 (0.0039)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Fillet roll		More than 0.1 (0.004)	

[1]: Always check with the Parts Department for the latest parts information

[2]: Total indicator reading

Bearing Clearance

INFOID:0000000006927486

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.047 (0.0008 - 0.0019)	0.1 (0.004)
Connecting rod bearing clearance	0.010 - 0.035 (0.0004 - 0.0014)	0.09 (0.0035)

Available Main Bearing

INFOID:0000000006927487

STANDARD

Unit: mm (in)

Grade number*	Thickness	Identification color
0	1.821 - 1.825 (0.0717 - 0.0719)	Black
1	1.825 - 1.829 (0.0719 - 0.0720)	Brown
2	1.829 - 1.833 (0.0720 - 0.0722)	Green
3	1.833 - 1.837 (0.0722 - 0.0723)	Yellow
4	1.837 - 1.841 (0.0723 - 0.0725)	Blue

*: Always check with the Parts Department for the latest parts information

UNDERSIZE (SERVICE)

Unit: mm (in)

	Thickness	Main journal diameter “Dm”
0.25 (0.0098)	1.952 - 1.960 (0.0769 - 0.0772)	Grind so that bearing clearance is the specified value.

Available Connecting Rod Bearing

INFOID:0000000006927488

STANDARD

Unit: mm (in)

Grade number*	Thickness	Identification color
0	1.505 - 1.508 (0.0593 - 0.0594)	—
1	1.508 - 1.511 (0.0594 - 0.0595)	Brown
2	1.511 - 1.514 (0.0595 - 0.0596)	Green

*: Always check with the Parts Department for the latest parts information

UNDERSIZE (SERVICE)

Unit: mm (in)

	Thickness	Crank pin journal diameter “Dp”
0.08 (0.0031)	1.540 - 1.548 (0.0606 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.560 - 1.568 (0.0614 - 0.0617)	
0.25 (0.0098)	1.625 - 1.633 (0.0640 - 0.0643)	

Miscellaneous Component

INFOID:0000000006927489

Unit: mm (in)

Camshaft sprocket runout [TIR]*	Less than 0.15 (0.0059)
Flywheel runout [TIR]*	Less than 0.15 (0.006)

* Total indicator reading

SERVICE INFORMATION

PRECAUTIONS

Precaution for Supplemental Restraint System (SRS) "AIR BAG" and "SEAT BELT PRE-TENSIONER"

INFOID:0000000006927490

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. Information necessary to service the system safely is included in the SRS and SB section of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the SRS section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

PRECAUTIONS WHEN USING POWER TOOLS (AIR OR ELECTRIC) AND HAMMERS

WARNING:

- **When working near the Airbag Diagnosis Sensor Unit or other Airbag System sensors with the Ignition ON or engine running, DO NOT use air or electric power tools or strike near the sensor(s) with a hammer. Heavy vibration could activate the sensor(s) and deploy the air bag(s), possibly causing serious injury.**
- **When using air or electric power tools or hammers, always switch the Ignition OFF, disconnect the battery, and wait at least 3 minutes before performing any service.**

Precaution for Draining Engine Coolant

INFOID:0000000006927491

Drain engine coolant when engine is cooled.

Precaution for Disconnecting Fuel Piping

INFOID:0000000006927492

- Before starting work, make sure no fire or spark producing items are in the work area.
- After disconnecting pipes, plug openings to stop fuel leakage.

Precaution for Removal and Disassembly

INFOID:0000000006927493

- When instructed to use SST, use the specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Cover openings of engine system with tape or the equivalent, if necessary, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and re-assembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified.

Precaution for Inspection, Repair and Replacement

INFOID:0000000006927494

Before repairing or replacing, thoroughly inspect parts. Inspect new replacement parts in the same way, and replace if necessary.

Precaution for Assembly and Installation

INFOID:0000000006927495

- Use torque wrench to tighten bolts or nuts to specification.
- When tightening nuts and bolts, as a basic rule, equally tighten in several different steps starting with the ones in center, then ones on inside and outside diagonally in this order. If the order of tightening is specified, do exactly as specified.
- Replace with new liquid gasket, packing, oil seal or O-ring.

- Dowel pins are used for several parts alignment. When replacing and reassembling parts with dowel pins, make sure that dowel pins are installed in the original position.
- Thoroughly wash, clean, and air-blow each part. Carefully check engine oil or engine coolant passages for any restriction and blockage.
- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- Release air within route when refilling after draining engine coolant.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust systems for leakage.

Parts Requiring Angle Tightening

INFOID:0000000006927496

- Use an angle wrench for the final tightening of the following engine parts:
- Cylinder head bolts
- Main bearing cap bolts
- Connecting rod cap nuts
- Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angle tightening)
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precaution for Liquid Gasket

INFOID:0000000006927497

REMOVAL OF LIQUID GASKET SEALING

- After removing the bolts and nuts, disconnect the component using a seal cutter.

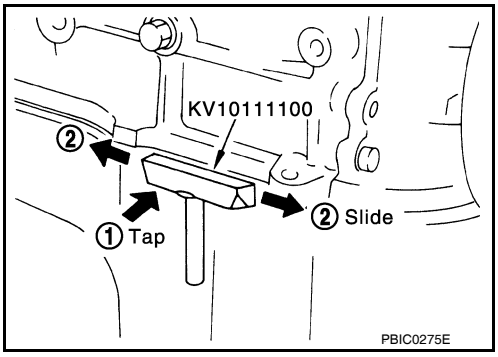
CAUTION:

Be careful not to damage the mating surfaces.

- Use a plastic hammer to lightly tap (1) the areas where the liquid gasket is applied. To advance the cutter, use a plastic hammer to slide (2) the cutter along the joint.

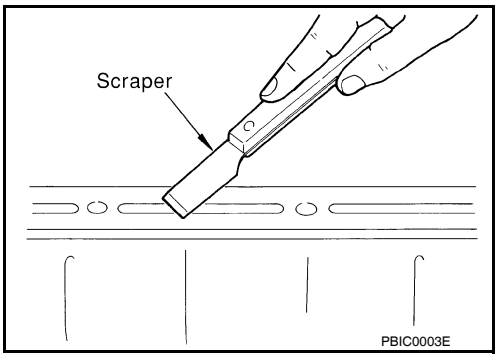
CAUTION:

If for some unavoidable reason a tool such as a flat-bladed screwdriver is used, be careful not to damage the mating surfaces.



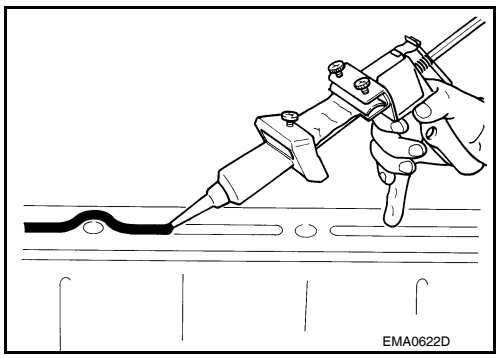
LIQUID GASKET APPLICATION PROCEDURE

1. Using a scraper, remove the old liquid gasket adhering to the gasket application surface and the mating surface.
   - Remove the sealant completely from the groove of the gasket application surface, bolts, and bolt holes.

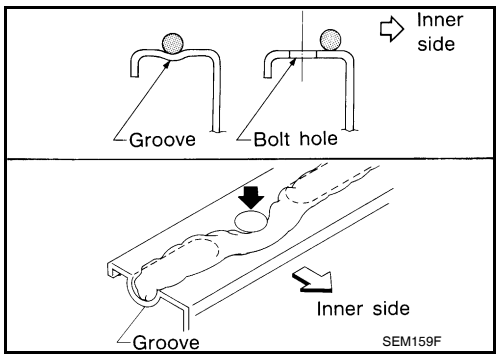


2. Thoroughly clean the gasket application surface and the mating surface and remove adhering moisture, grease and foreign materials.

3. Attach the sealant tube to the tube presser.



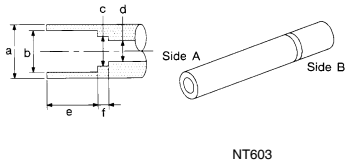
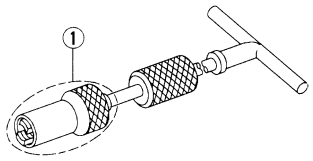
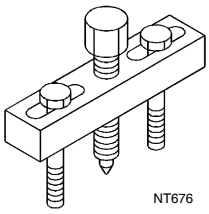
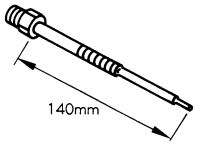
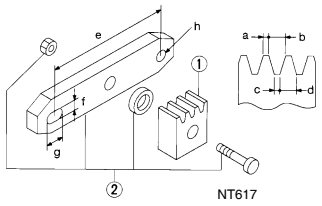
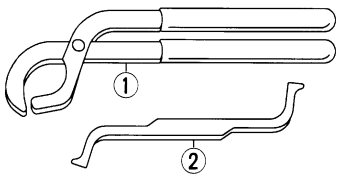
4. Apply the sealant without breaks to the specified location with the specified dimensions.
   - If there is a groove for the sealant application, apply the sealant to the groove.
   - As for the bolt holes, normally apply the sealant inside the holes. If specified, it should be applied outside the holes. Make sure to read the text of this manual.
   - Within five minutes of the sealant application install the mating component.
   - If the sealant protrudes, wipe it off immediately.
   - Do not retighten after the installation.
   - After 30 minutes or more have passed from the installation, fill the engine with the specified oil and coolant. Refer to LU-19, "Changing Engine Oil" and CO-33, "Changing Engine Coolant".

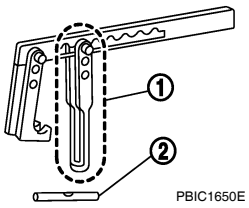
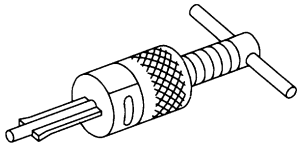
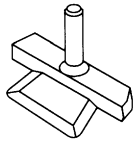
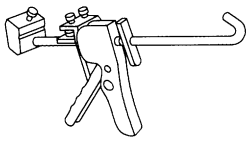
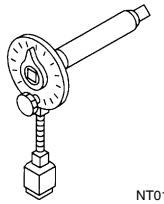
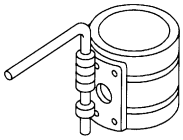
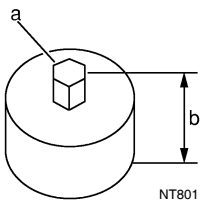


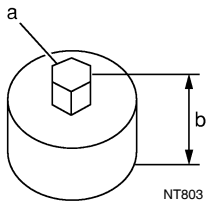
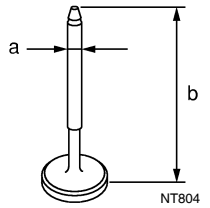
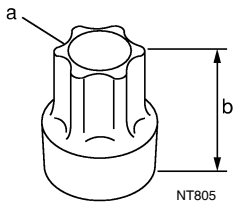
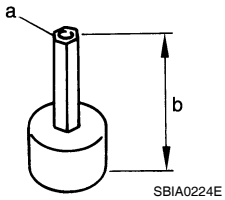
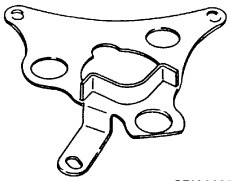
PREPARATION

Special Service Tool

INFOID:0000000006927498

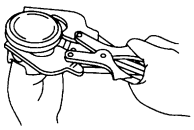
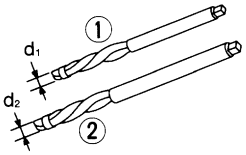
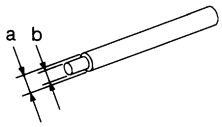
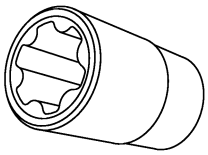
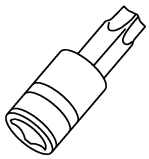
Tool number Tool name	Description
KV10115600 Valve oil seal drift  NT603	Installing valve oil seal **Use side A.** **Side A** **a: 20 (0.79) dia.** **b: 13 (0.51) dia.** **c: 10.3 (0.406) dia.** **d: 8 (0.31) dia.** **e: 10.7 (0.421)** **f: 5 (0.20)** Unit: mm (in)
KV10107902 Valve oil seal puller 1. KV10116100 Valve oil seal puller adapter  S-NT605	Removing valve oil seal
KV11103000 Pulley puller  NT676	Removing crankshaft pulley
ED19600610 Compression gauge adapter  ZZA1188D	Checking compression pressure
KV101056S0 Ring gear stopper 1. KV10105630 Adapter 2. KV10105610 Plate  NT617	Preventing crankshaft from rotating **a: 3 (0.12)** **b: 6.4 (0.252)** **c: 2.8 (0.110)** **d: 6.6 (0.260)** **e: 107 (4.21)** **f: 14 (0.55)** **g: 20 (0.79)** **h: 14 (0.55) dia.** Unit: mm (in)
KV101151S0 Lifter stopper set 1. KV10115110 Camshaft pliers 2. KV10115120 Lifter stopper  NT041	Changing adjusting shim

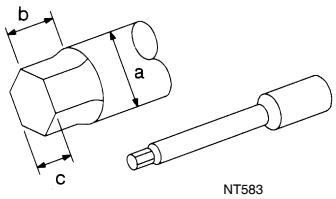
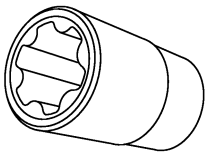
Tool number Tool name		Description
KV10116200 Valve spring compressor 1. KV10115900 Attachment 2. KV10109220 Adapter	 PBIC1650E	Disassembling and assembling valve mechanism Part (1) is a component of KV10116200, but Part (2) is not so.
ST16610001 Pilot bushing puller	 NT045	Removing crankshaft pilot bush
KV10111100 Seal cutter	 NT046	Removing oil pan upper, oil pan lower and rear chain case, etc.
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket
KV10112100 Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.
EM03470000 Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
KV11106010 Hexagon wrench	 NT801	Removing and installing chain tensioner **a: 5 mm (0.20 in) (Face to face)** **b: 20 mm (0.79 in)**

Tool number Tool name		Description
KV11106020 Hexagon wrench		Removing and installing slack guide **a: 6 mm (0.24 in) (Face to face)** **b: 20 mm (0.79 in)**
KV11106030 Positioning stopper pin		Holding fuel pump sprocket **a: 6 mm (0.24 in) dia.** **b: 80 mm (3.15 in)**
KV11106040 TORX wrench		Removing and installing fuel pump sprocket nut **a: T70** **b: 26 mm (1.02 in)**
KV11106050 Hexagonal wrench		Removing and installing fuel pump sprocket **a: 6 mm (0.24 in) (Face to face)** **b: 42 mm (1.65 in)**
KV11106060 Sprocket holder		Holding fuel pump sprocket

Commercial Service Tool

INFOID:0000000006927499

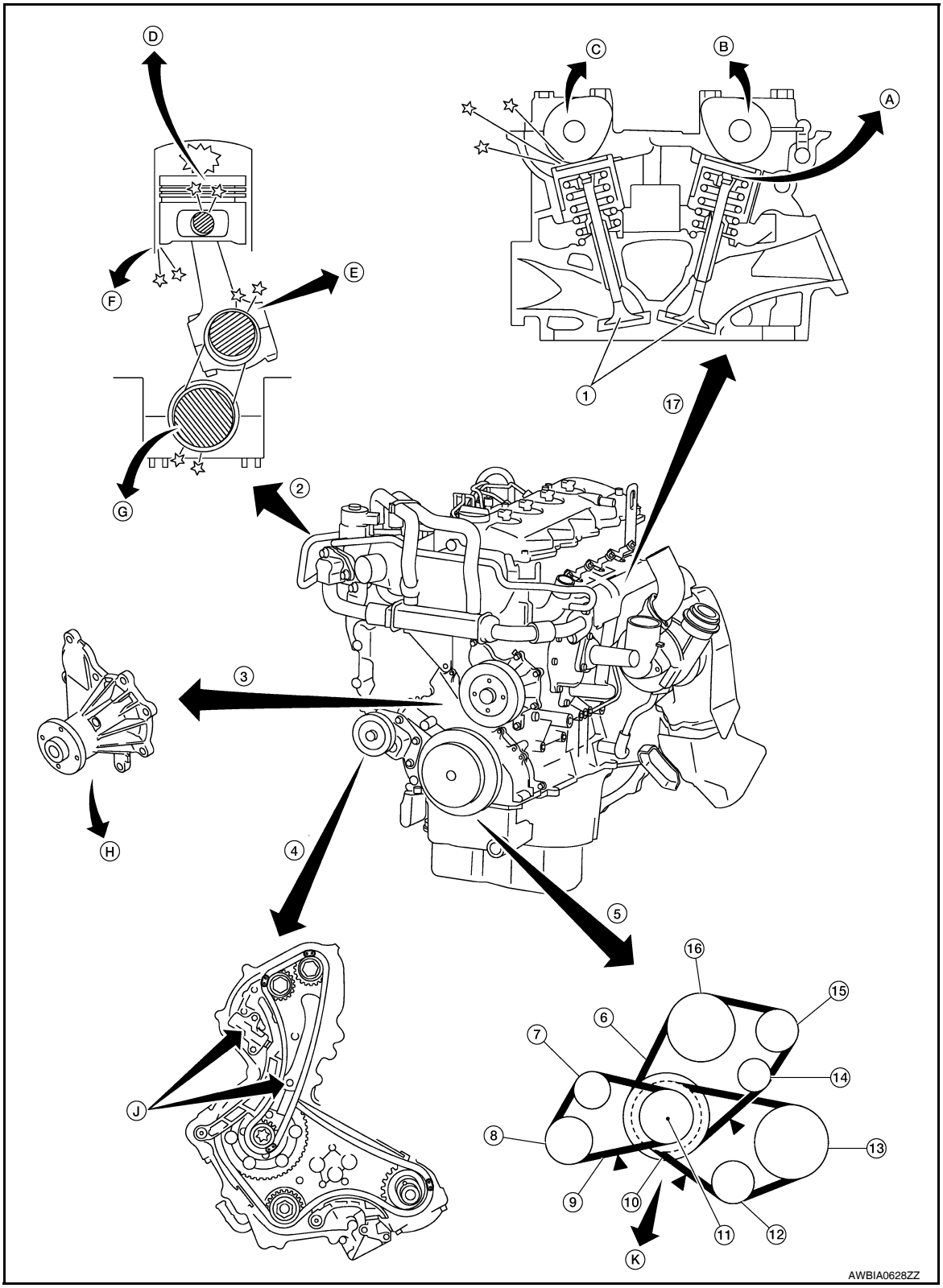
Tool name	Description
Valve seat cutter set NT048	Finishing valve seat dimensions
Piston ring expander  NT030	Removing and installing piston ring
Valve guide reamer  NT016	Reaming valve guide with (1) or hole for over-size valve guide with (2) **Intake and Exhaust:** **d_1 = 6.0 mm (0.236 in) dia.** **d_2 = 10.2 mm (0.402 in) dia.**
Valve guide drift  NT015	Removing and installing valve guide **Intake and Exhaust:** **a = 9.5 mm (0.374 in) dia.** **b = 5.5 mm (0.217 in) dia.**
TORX socket  NT807	Loosening and tightening fuel pump bolt **Size: E10**
TORX socket  PBIC1113E	Loosening and tightening flywheel bolt **Size: T55**

Tool name	Description
Cylinder head bolt wrench  NT583	Loosening and tightening cylinder head bolt, and used with angle wrench [SST: KV10112100] **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
TORX socket  NT807	Loosening and tightening main bearing cap bolt **Size: E14**

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:0000000006927500



1. Valve
2. Rotation mechanism
3. Water pump
4. Timing chain
5. Drive belt
6. Generator and water pump belt

7. Idler pulley
8. Power steering pump pulley
9. Power steering pump belt
10. A/C compressor belt
11. Crankshaft pulley
12. Idler pulley
13. A/C compressor pulley
14. Idler pulley
15. Generator pulley
16. Water pump pulley
17. Valve mechanism
A. Tappet noise
B. Camshaft bearing noise (exhaust)
C. Camshaft bearing noise (intake)
D. Piston pin noise
E. Connecting rod bearing noise
F. Piston slap noise
G. Main bearing noise
H. Water pump noise
J. Timing chain and chain tensioner noise
K. Drive belt noise (stick/slipping)

Use the Chart Below to Help You Find the Cause of the Symptom

INFOID:0000000006927501

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-138
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft oil clearance Camshaft runout	EM-132 EM-132
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin clearance Connecting rod bushing oil clearance	EM-192 EM-192
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-192 EM-192 EM-192 EM-192
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance (Big end)	EM-192 EM-192
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-192 EM-192
Front of engine Timing chain case	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-146 EM-153 EM-152

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-88
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-40

A: Closely related B: Related C: Sometimes related —: Not related

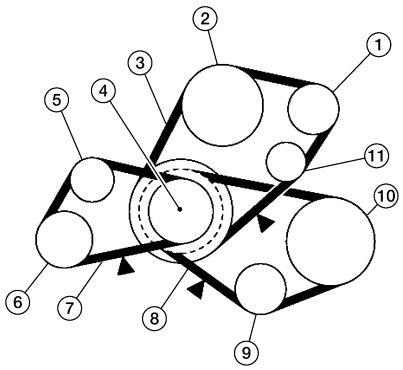
DRIVE BELTS

Checking Drive Belts

INFOID:0000000006927502

INSPECTION

SEC. 117



AWBIA0629ZZ

1. Generator pulley
2. Water pump pulley
3. Generator and water pump belt
4. Crankshaft pulley
5. Idler pulley
6. Power steering pump pulley
7. Power steering pump belt
8. A/C compressor belt
9. Idler pulley
10. A/C compressor pulley
11. Idler pulley

- Before inspecting engine, make sure engine has cooled down; wait approximately 30 minutes after engine has been stopped.
- Visually inspect all belts for wear, damage or cracks on contacting surfaces and edge areas.
- Measure deflection at the marked point (▲).

CAUTION:

- **When checking belt deflection immediately after installation, first adjust it to the specified value. Then, after turning crankshaft two turns or more, re-adjust to the specified value to avoid variation in deflection between pulleys.**
- **Tighten idler pulley lock nut by hand and measure deflection without looseness.**

Belt Deflection:

Applied belt	Belt deflection with 98 N (10 kg, 22 lb) force applied* mm (in)		
	New	Adjusted	Limit for re-adjusting
A/C compressor belt	7.0 - 8.0 (0.276 - 0.315)	9.5 - 10.5 (0.374 - 0.413)	12.0 (0.472)
Generator and water pump belt	6.5 - 7.5 (0.256 - 0.295)	8.0 - 9.5 (0.315 - 0.374)	12.5 (0.492)
Power steering pump belt	6.5 - 7.5 (0.256 - 0.295)	8.0 - 10.0 (0.315 - 0.394)	11.5 (0.453)

*: When engine is cold.

ADJUSTMENT

CAUTION:

- **When a new belt is installed as a replacement, adjust it to the value specified under "New" accommodations because of insufficient adaptability with pulley grooves.**
- **If the belt deflection of the current belt is out of the "Limit for re-tightening", adjust to the "Adjusted" value.**
- **When checking belt deflection immediately after installation, first adjust it to the specified value. Then, after turning crankshaft two turns or more, re-adjust it to the specified value to avoid variation in deflection between pulleys.**
- **Make sure the belts are fully positioned into the pulley grooves during installation.**

- **Handle with care to avoid spilling engine oil or engine coolant on belts.**
- **Do not twist or bend the belts with excessive force.**

A/C compressor belt (3) and power steering pump belt (2)

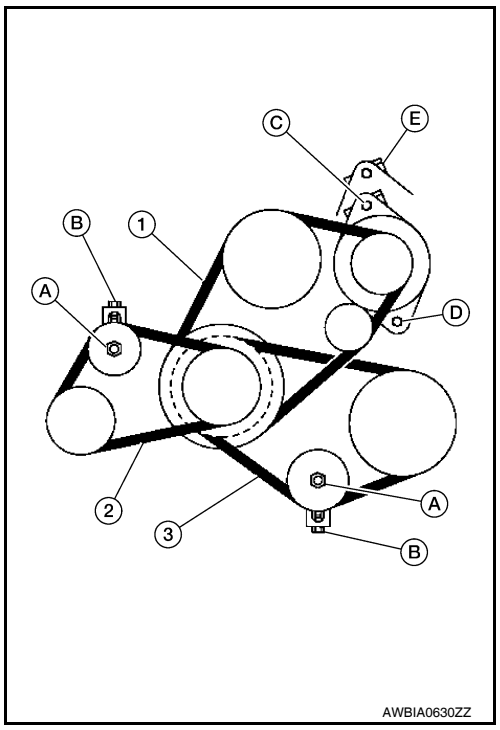
1. Loosen idler pulley lock nut (A).
2. Turn adjusting bolt (B) to adjust.
3. Tighten lock nut (A).

Lock nut (A) : 54 N·m (5.5 kg-m, 40 ft-lb)

Generator and water pump belt (1)

1. Loosen adjuster lock nut (C).
2. Loosen generator nut (D) (rear).
3. Turn adjusting bolt (E) to adjust.
4. Tighten lock nut (C) and (D) in this order.

Lock nut (C) : 18.1 N·m (1.8 kg-m, 13 ft-lb)
Lock nut (D) : 50.5 N·m (5.2 kg-m, 37 ft-lb)



AWBIA0630ZZ

Removal and Installation

INFOID:0000000006927503

REMOVAL

1. Remove engine undercover if removing A/C compressor belt.
2. Loosen each belt adjustment. Refer to EM-88, "Checking Drive Belts".
3. Remove power steering oil pump belt. Refer to EM-88, "Checking Drive Belts".
4. Remove A/C compressor, generator and water pump belt. Refer to EM-88, "Checking Drive Belts".

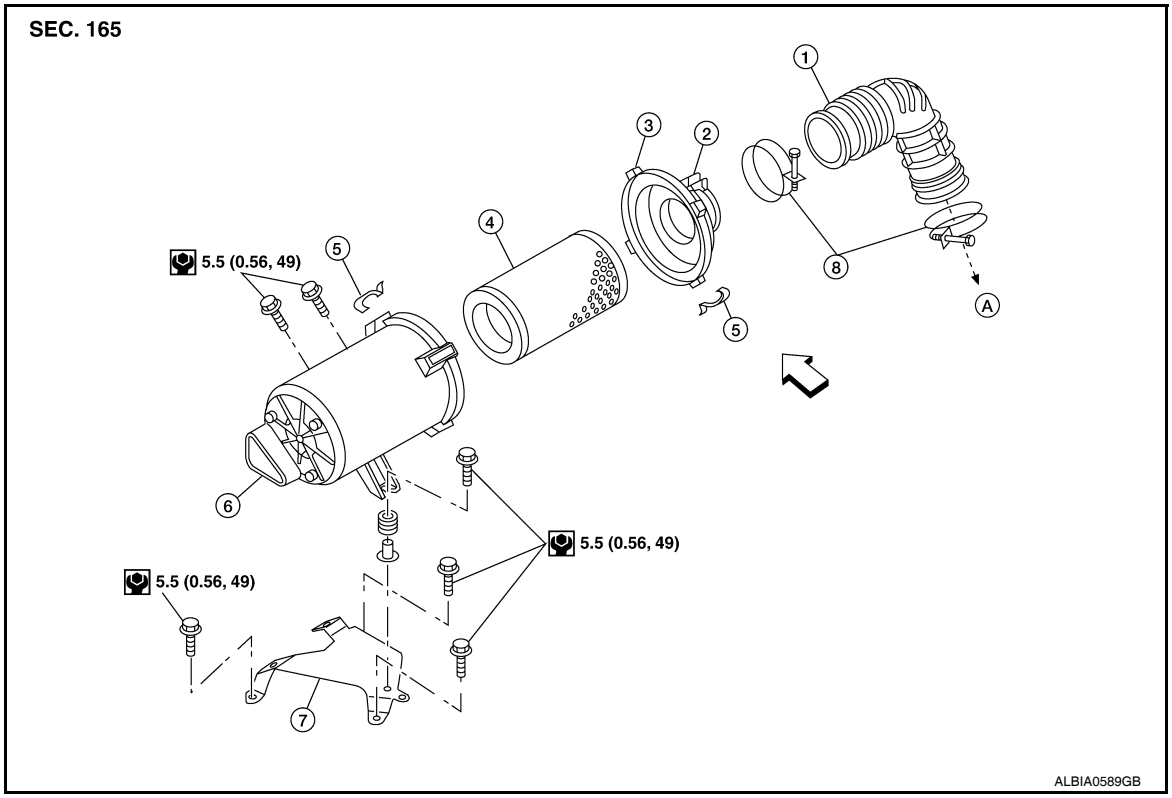
INSTALLATION

1. Install each belt on pulley in the reverse order of removal.
2. Adjust belt deflection. Refer to EM-88, "Checking Drive Belts".
3. Tighten nuts provided for adjustment to the specified torque. Refer to EM-88, "Checking Drive Belts".
4. Make sure again that each belt deflection is as specified. Refer to EM-88, "Checking Drive Belts".

AIR CLEANER AND AIR DUCT

Component

INFOID:0000000006927504



1. Air duct
2. Mass air flow sensor
3. Air cleaner case cover
4. Air cleaner filter
5. Clip
6. Air cleaner case
7. Air cleaner assembly bracket
8. Clamp
⇦ Front
A. To turbocharger

Removal and Installation

INFOID:0000000006927505

REMOVAL

1. Disconnect harness connector from mass air flow sensor.
2. Loosen clamps and remove air duct.
   • Add marks as necessary for easier installation.
3. Remove air cleaner assembly bolts and remove air cleaner assembly.
4. Remove mass air flow sensor from air cleaner case cover, if necessary.
   CAUTION:
   • **Do not shock it.**
   • **Do not disassemble it.**
   • **Do not touch its sensor.**
5. Remove air cleaner assembly bracket bolts and air cleaner assembly bracket, if necessary.

INSTALLATION

Installation is in the reverse order of removal.
• Align marks. Attach each joint. Tighten clamps firmly.

CHANGING AIR CLEANER FILTER

Removal

1. Disconnect harness connector from mass air flow sensor.

2. Loosen clamps and remove air duct.
   • Add marks as necessary for easier installation.
3. Release clips and remove air cleaner case cover.
4. Remove air cleaner filter.

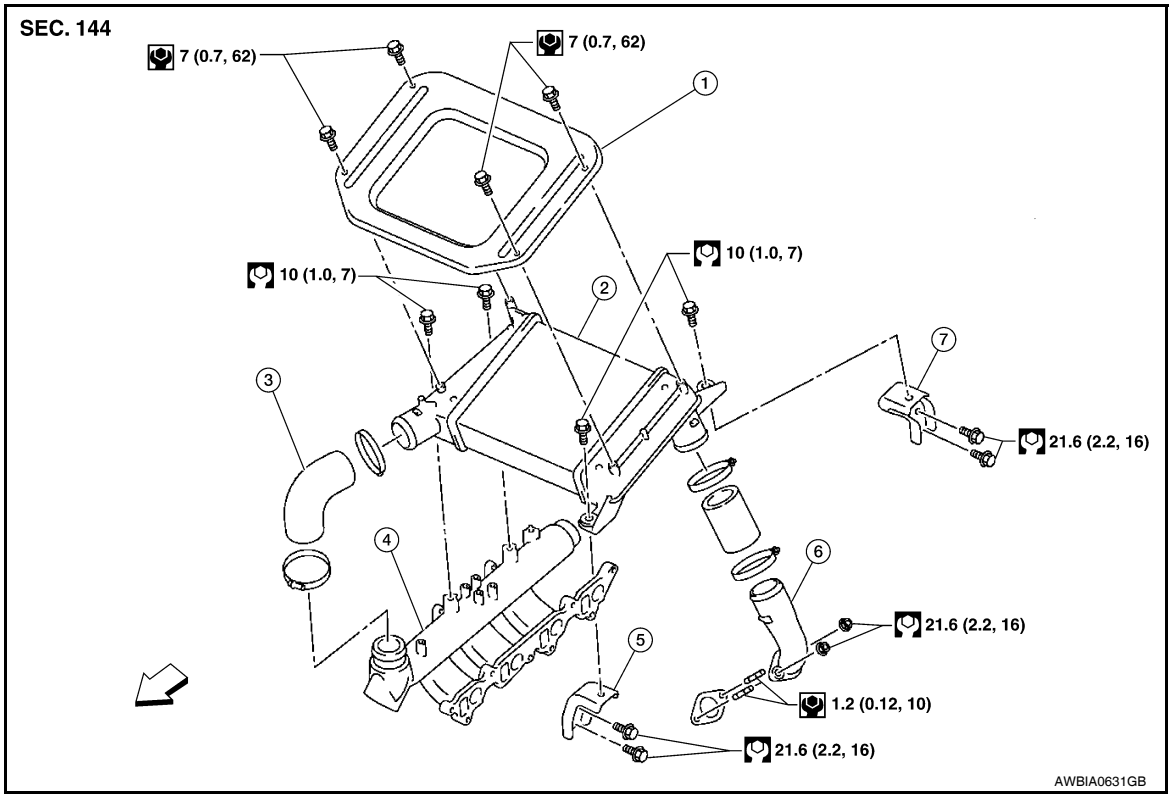
Installation

Installation is in the reverse order of removal.

CHARGE AIR COOLER

Component

INFOID:0000000006927506



1. Charge air cooler cover
2. Charge air cooler
3. Air inlet hose
4. Intake manifold
5. Bracket
6. Air inlet pipe
7. Bracket
⇦ Front

Removal and Installation

INFOID:0000000006927507

REMOVAL

CAUTION:

When removing charge air cooler, cover opening on turbocharger and on intake manifold with shop cloth or other suitable material.

1. Remove charge air cooler cover.
2. Remove air inlet hoses.
   - Add marks as necessary for easier installation.
3. Remove charge air cooler.
4. Remove air inlet pipe, if necessary.

INSPECTION AFTER REMOVAL

Check air passages of charge air cooler core and fins for clogging, leaks or deformation. Clean or replace charge air cooler if necessary.

- **Be careful not to deform core fins.**
- **For cleaning procedure of charge air cooler core, refer to CO-32, "System Inspection".**

INSTALLATION

Installation is in the reverse order of removal.

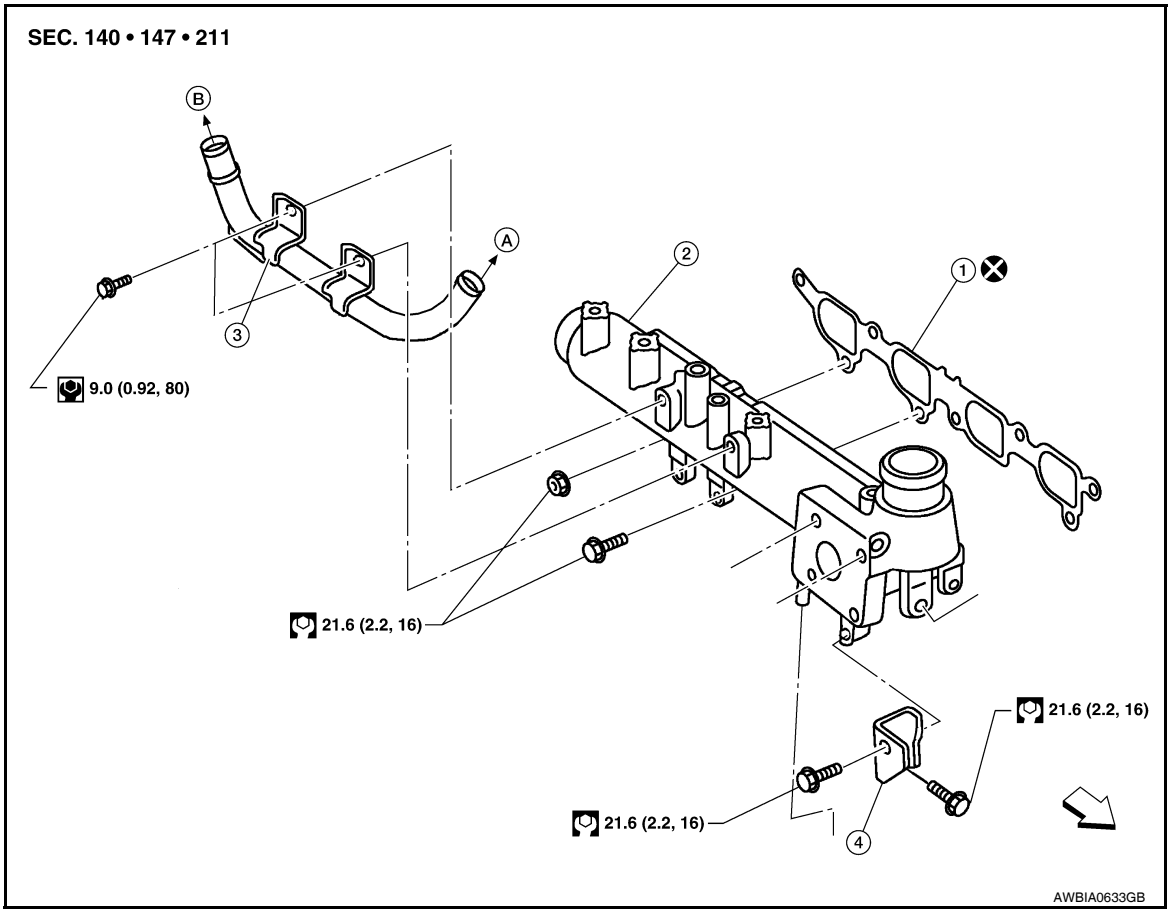
- Pay attention to identification mark color and direction when installing air inlet hoses.
- Align marks. Attach each joint. Screw clamps firmly.

INTAKE MANIFOLD

Component

INFOID:0000000006927508

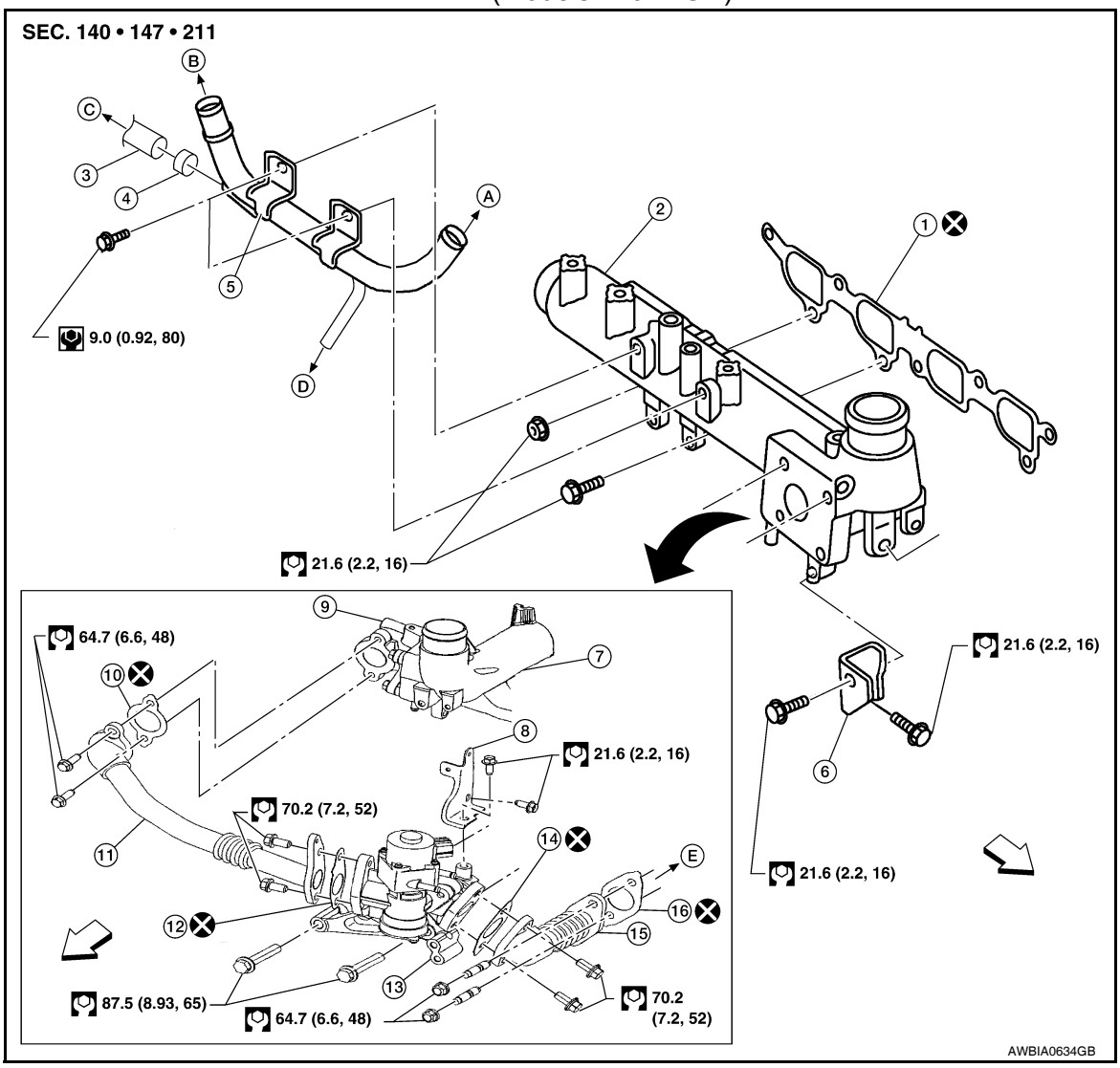
TYPE 1 (Models Without EGR)



1. Gasket
2. Intake manifold
3. Heater feed pipe
4. Intake manifold support
A. To cylinder head
B. To heater core

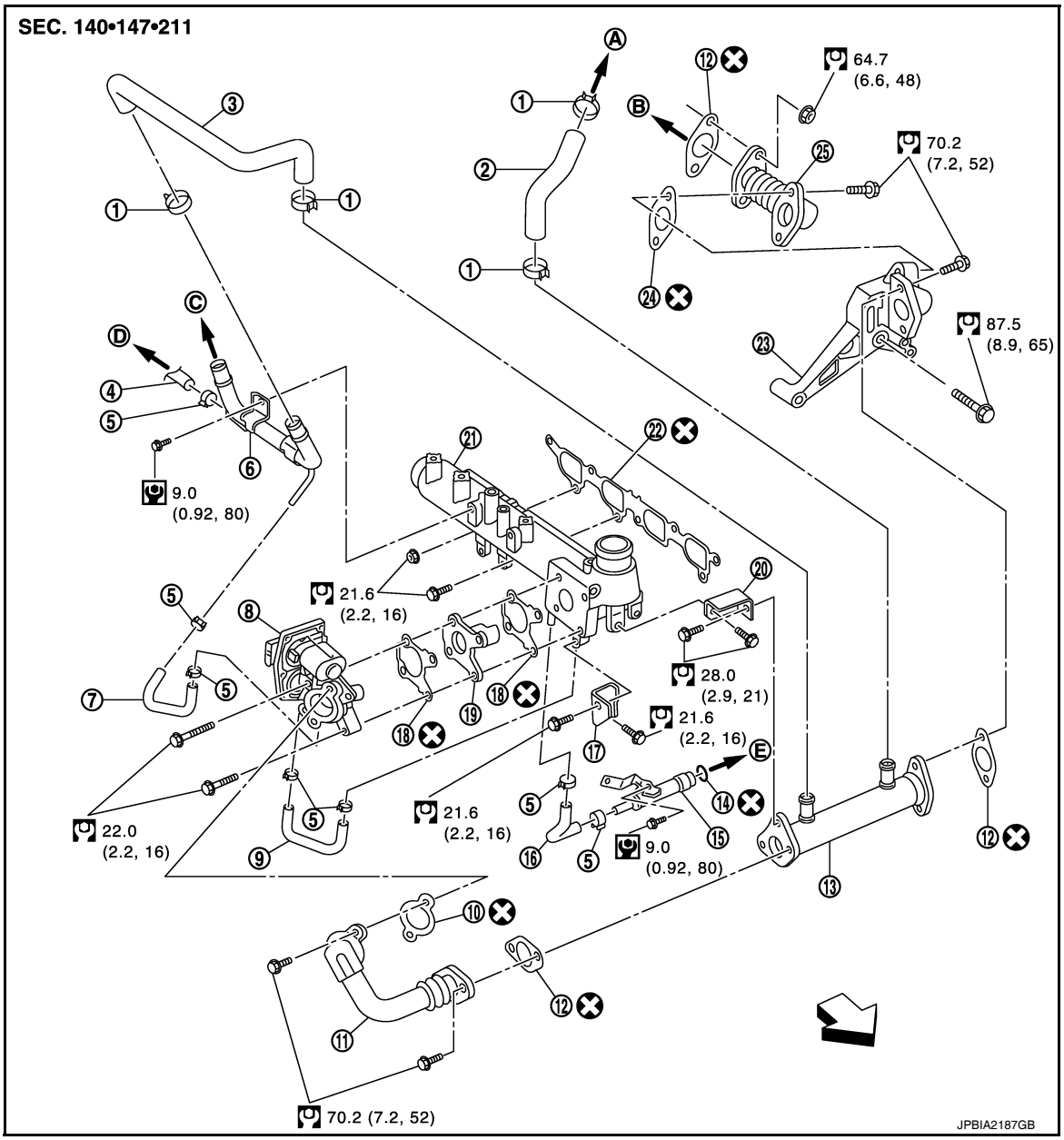
⇦ Front

TYPE 1 (Models With EGR)



1. Gasket
2. Intake manifold
3. Water hose
4. Clamp
5. Heater feed pipe
6. Intake manifold support
7. Intake manifold
8. EGR valve support bracket
9. EGR adapter
10. Gasket
11. EGR tube
12. Gasket
13. EGR assembly
14. Gasket
15. EGR tube
16. Gasket
A. To cylinder head
B. To heater core
C. To heater return pipe
D. To EGR assembly
E. To exhaust manifold
⇦ Front

TYPE 2



1. Clamp
2. Water hose
3. Water hose
4. Water hose
5. Clamp
6. Heater feed pipe
7. Water hose
8. EGR volume control valve
9. Water hose
10. Gasket
11. EGR guide tube
12. Gasket
13. EGR cooler
14. O-ring
15. Water pipe assembly
16. Water hose
17. Intake manifold support
18. Gasket
19. EGR passage
20. EGR cooler bracket
21. Intake manifold
22. Gasket
23. EGR spacer
24. Gasket
25. EGR tube
A. To water outlet
B. To exhaust manifold
C. To heater core
D. To heater return pipe
E. To cylinder head
⇦ Front

Removal and Installation

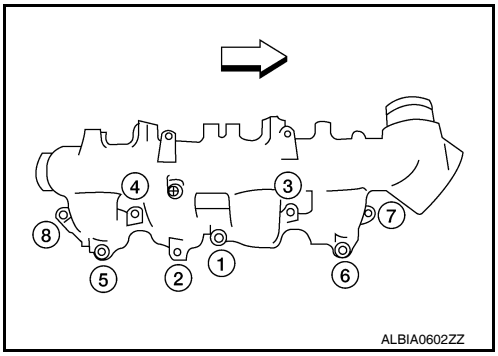
INFOID:0000000006927509

REMOVAL

WARNING:

To avoid the danger of being scalded, do not drain engine coolant when engine is hot.

1. Drain engine coolant. Refer to CO-33, "Changing Engine Coolant".
2. Remove charge air cooler. Refer to EM-92, "Component".
3. Remove oil level gauge guide. Refer to EM-108, "Component".
4. Remove fuel hoses and fuel gallery. Refer to EM-117, "Component".
   - To prevent fuel from flowing out, plug the opening of the hose with plug after disconnection.
   CAUTION:
   Be careful not to spill fuel in the engine compartment.
   - Add marks as necessary for easier installation.
5. Remove vacuum galleries and vacuum hoses.
   - Add marks as necessary for easier installation.
6. Disconnect EGR volume control valve water hoses and wiring harness, if equipped.
7. Disconnect heater feed hose, water hoses, and remove heater feed pipe.
8. Remove EGR cooler (TYPE 2) or EGR tube (TYPE 1), if equipped.
9. Remove injection tube center. Refer to EM-117, "Removal and Installation".
   CAUTION:
   Be careful not to spill fuel in the engine compartment.
10. Remove water pipe.
11. Loosen bolts and nuts in the reverse order of that shown and remove intake manifold.
    - ⇦: Front
    CAUTION:
    Cover engine openings to avoid entry of foreign materials.



12. Remove EGR volume control valve and throttle chamber from intake manifold, if equipped.

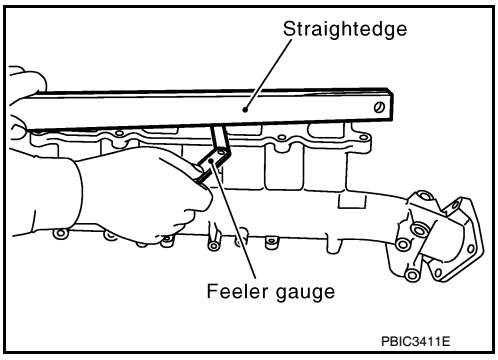
INSPECTION AFTER REMOVAL

Surface Distortion

- Check distortion on the mounting surface with a straightedge and feeler gauge.

Limit : 0.1 mm (0.004 in)

- If it exceeds the limit, replace intake manifold.



INSTALLATION

Installation is in the reverse order of removal.

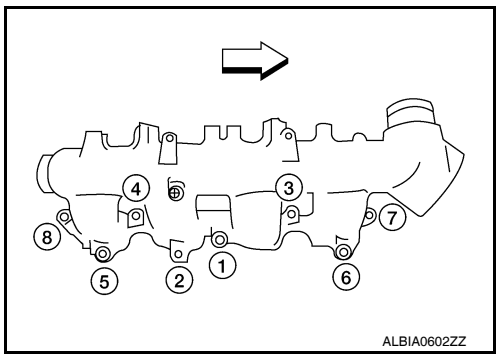
- Install intake manifold.

- Tighten intake manifold bolts and nuts in numerical order as shown.

• ⇦: Front

- If stud bolts were removed, tighten them to specification.

Stud bolts : 10.8 N·m (1.1 kg-m, 8 ft-lb)



• Install EGR cooler and EGR volume control valve, if equipped.
• Install water hoses and heater feed hose.

- Install water hose by referring to paint marks and avoid twisting.
- When an insert stopper is provided on the pipe side, insert the hose until it reaches the stopper.

• Before starting engine, bleed air from fuel piping. Refer to EC-481, "Fuel Filter" or EC-726, "Fuel Filter".

INSPECTION AFTER INSTALLATION

Start engine and increase engine speed to check for fuel leak.

CAUTION:

Do not touch the engine immediately after stopped as engine becomes extremely hot.

NOTE:

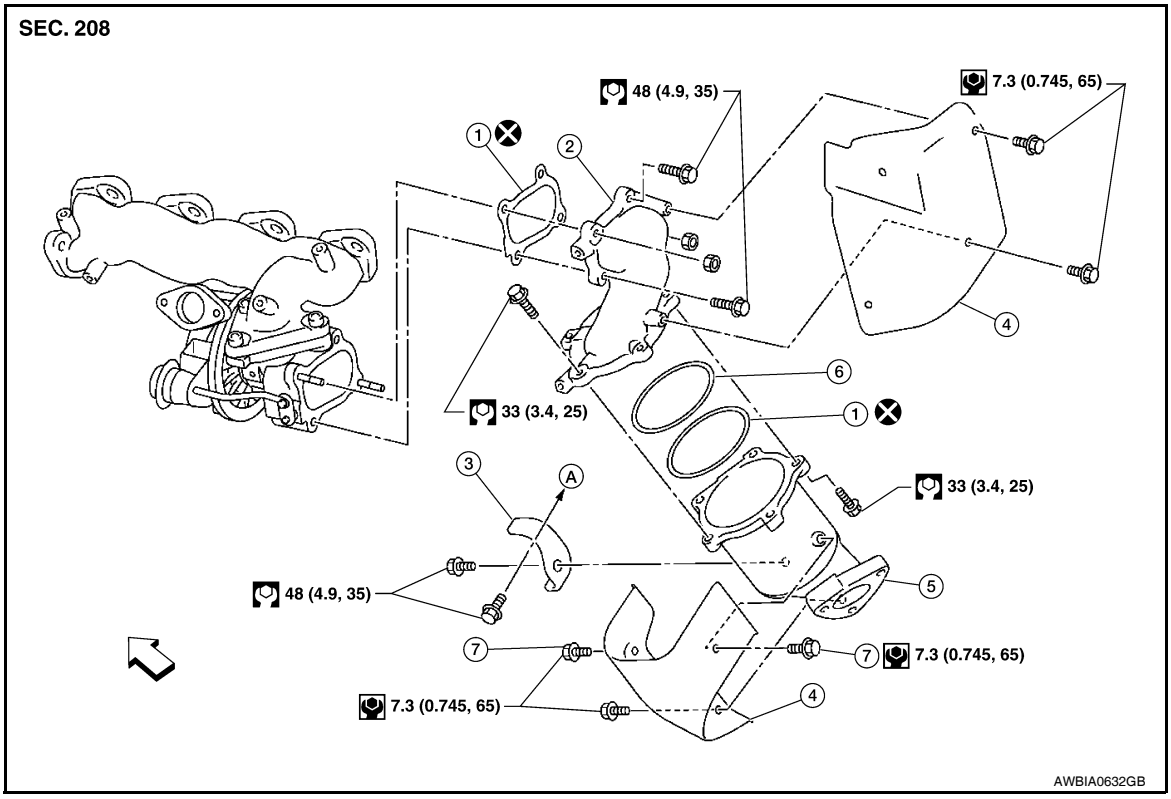
Use mirrors for checking at points out of clear sight.

CATALYST

Component

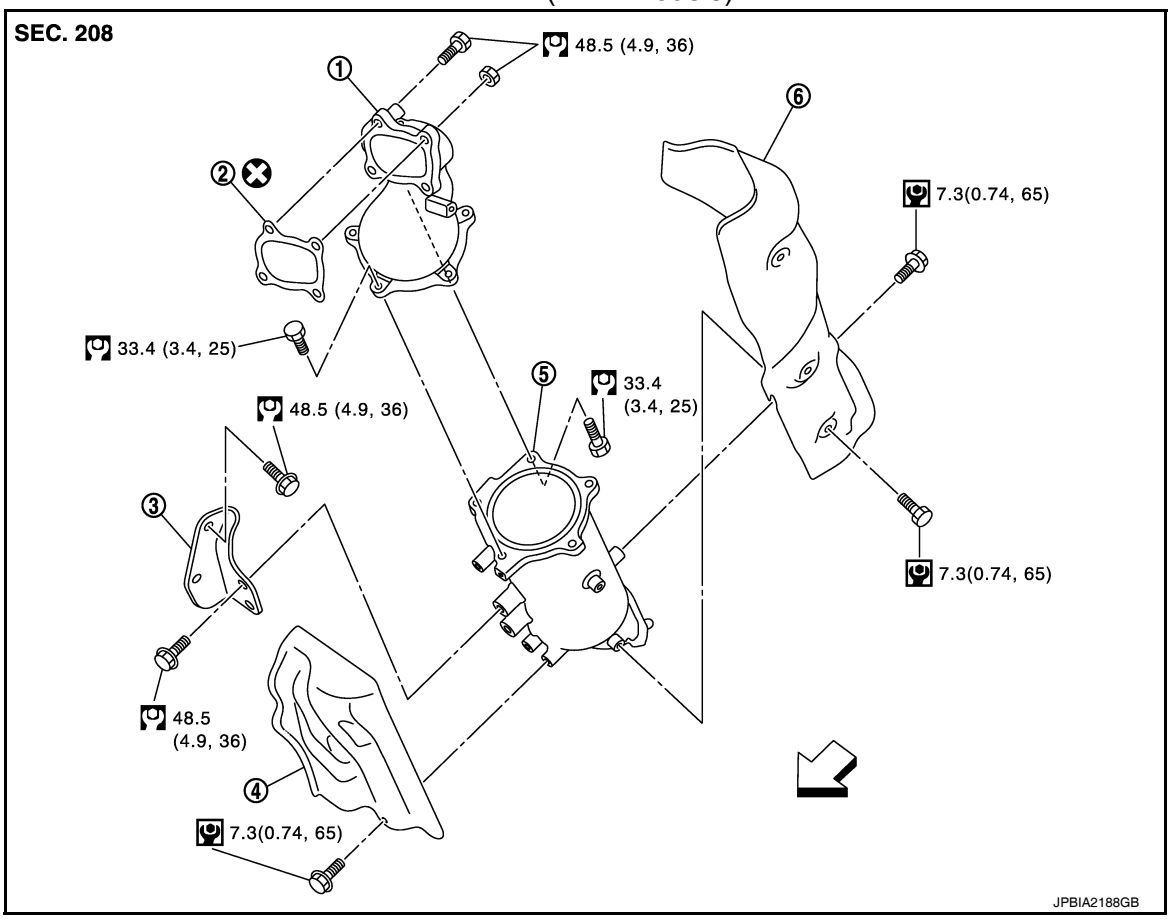
INFOID:0000000006927510

TYPE 1 and TYPE 2 (4WD Models)



1. Gasket
2. Exhaust outlet
3. Gusset
4. Catalyst cover
5. Catalyst
6. Gasket cap
7. Locking pin
A. To oil pan
⇦ Front

TYPE 2 (2WD Models)



1. Exhaust outlet
2. Gasket
3. Gusset
4. Catalyst cover
5. Catalyst
6. Catalyst cover

⇦ Front

Removal and Installation

INFOID:0000000006927511

REMOVAL

1. Remove catalyst covers.
2. Remove exhaust front tube. Refer to EX-6, "Removal and Installation".
3. Remove exhaust manifold cover. Refer to EM-105, "Component".
4. Remove catalyst and exhaust outlet.
5. Remove catalyst from exhaust outlet, if necessary.

INSTALLATION

Note the following, and install in the reverse order of removal.

- If stud bolts of turbocharger were removed, tighten them to specification.

: **25.5 N·m (2.6 kg-m, 19 ft-lb)**

- If stud bolts of catalyst were removed, tighten them to specification.

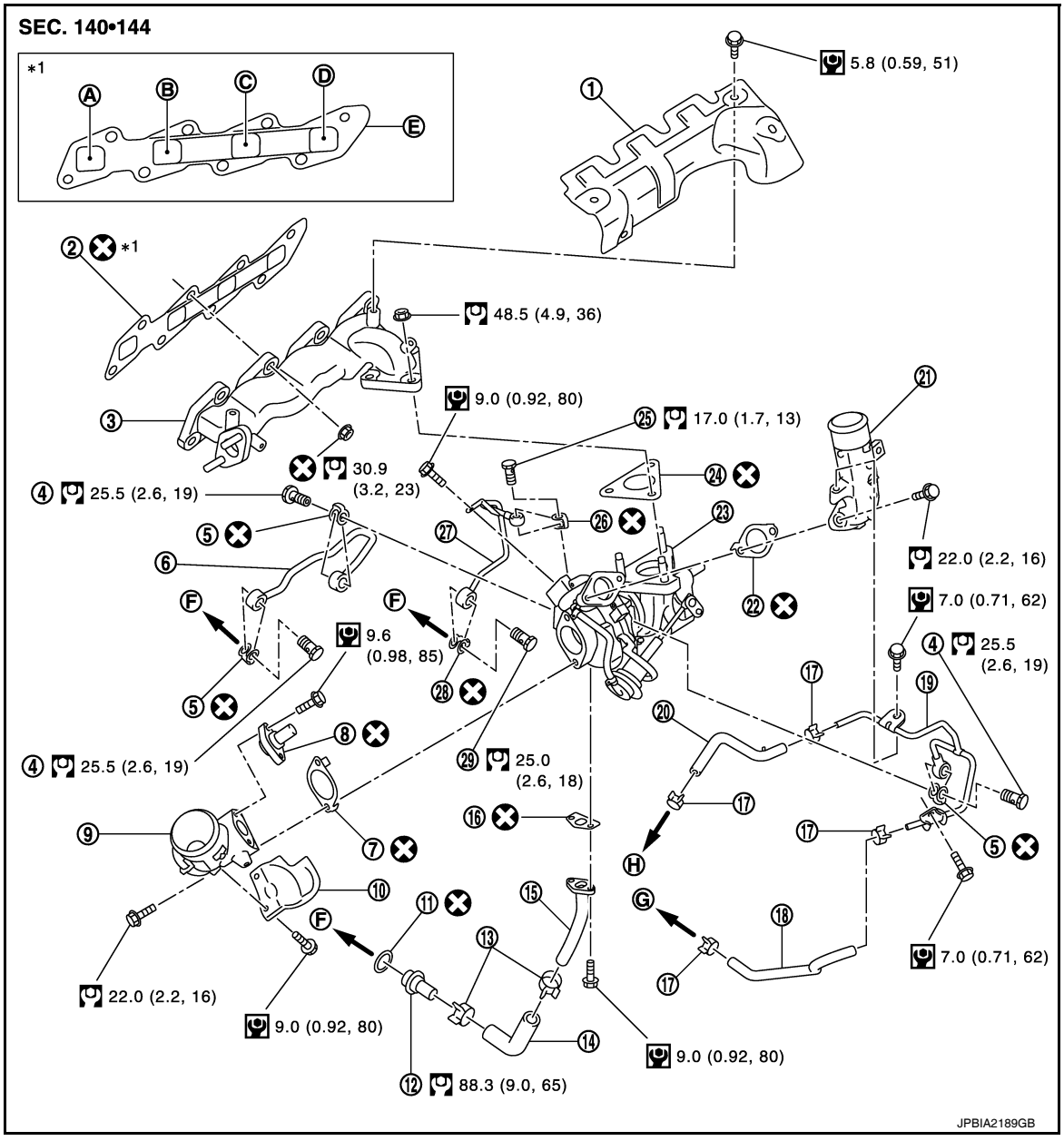
: **45.0 N·m (4.6 kg-m, 33 ft-lb)**

- Pushing bracket against the cylinder block and the catalyst, temporarily tighten the bolt. And then tighten it to specification.

TURBO CHARGER

Component

INFOID:0000000006927512



1. Exhaust manifold cover
2. Gasket
3. Exhaust manifold
4. Eye-bolt
5. Copper washer
6. Water feed pipe
7. Gasket
8. Ventilation hose connector
9. Air inlet tube
10. Insulator
11. Gasket
12. Connector
13. Clamp
14. Oil return hose
15. Oil return tube
16. Gasket
17. Clamp
18. Water hose
19. Water return tube
20. Water hose
21. Air inlet tube
22. Gasket
23. Turbocharger
24. Gasket
25. Eye-bolt
26. Copper washer
27. Oil feed pipe
28. Copper washer
29. Eye-bolt
A. No. 1
B. No. 2
C. No. 3
D. No. 4

E. Alignment protrusion F. To cylinder block G. To heater return pipe
H. To water outlet

Removal and Installation

INFOID:0000000006927513

REMOVAL

CAUTION:

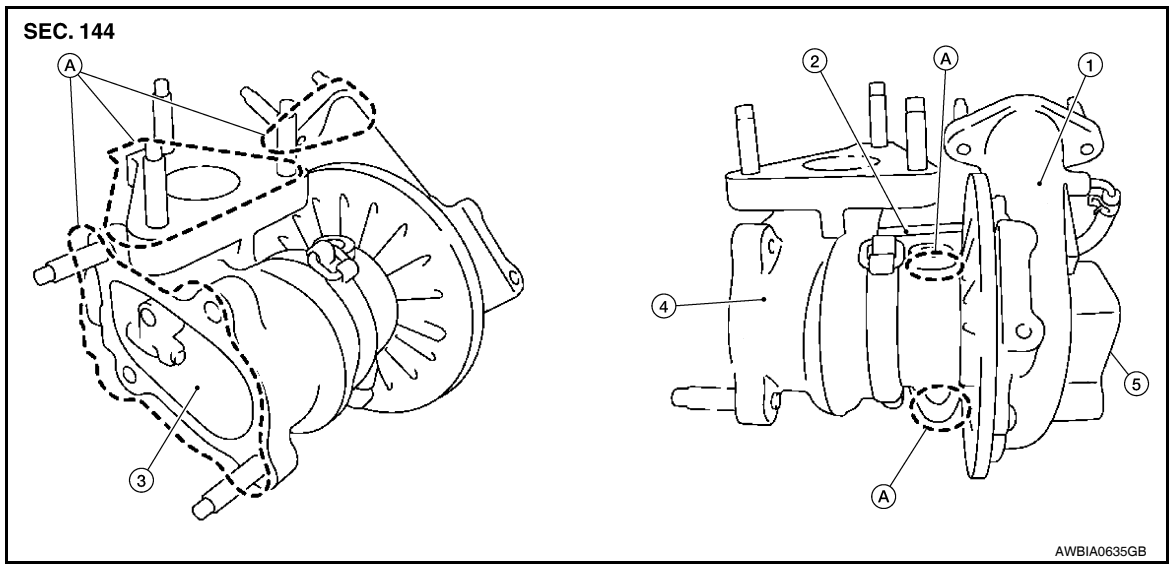
- **There are two kinds of turbochargers, one with an identification mark (blue mark), and the other without an identification mark.**
- **When replacing a turbocharger without an identification mark, never install a turbocharger with an identification mark.**
- **Be careful not to deform water tube, oil feed tube and oil return tube.**
- **Never disassemble or adjust the turbocharger.**
- **Be careful not to bring turbocharger into contact with the vehicle.**
- **Never hold turbocharger boost control actuator and actuator rod.**
- After applying penetrative lubricant to the nuts, check for the penetration of the lubricant, and then loosen the nuts to remove.

1. Drain engine coolant. Refer to CO-33, "Changing Engine Coolant".
2. Remove air cleaner and air duct. Refer to EM-90, "Component".
3. Remove air inlet hose and air inlet pipe. Refer to EM-92, "Component".
4. Remove exhaust manifold cover. Refer to EM-105, "Component".
5. Remove exhaust outlet and catalyst. Refer to EM-98, "Component".
6. Remove eye bolts and hose from water tube, oil feed pipe and oil return tube.
7. Remove turbocharger with water tube, oil feed pipe and oil return tube.
8. Remove water tube, oil feed pipe and oil return tube from turbocharger.
9. Remove turbocharger.

Oil Tube and Water Tube

- Clean inside of oil feed pipe, oil return tube and water tube, and check tubes for clogging.
- Replace oil feed pipe, oil return tube and/or water tube if clogging still exists after cleaning.

INSPECTION AFTER REMOVAL



1. Compressor housing 2. Actuator assembly 3. Turbine wheel
4. Turbine housing and turbine wheel 5. Compressor wheel A. Check for leaks

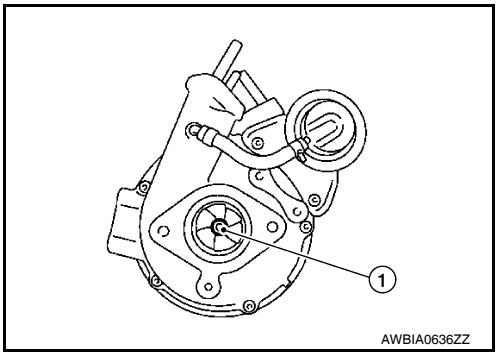
CAUTION:

When the compressor wheel turbine, wheel or rotor shaft is damaged, remove all the fragments and foreign matter left in the following passages in order to prevent a secondary malfunction:

Suction side : Between turbocharger and charge air cooler
Exhaust side : Between turbocharger and catalyst

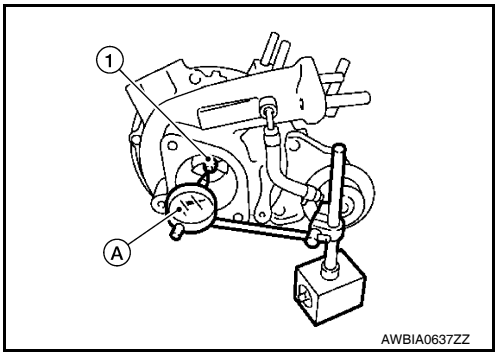
Rotor Shaft Clearance

- Make sure that the rotor shaft (1) rotates smoothly without any resistance when it is rotated by your fingertips.
- Make sure that the rotor shaft (1) is not loose when it is moved vertically or horizontally.
- Make sure that the rotor shaft (1) does not interfere with the compressor housing.
- Replace turbocharger if out of standard.



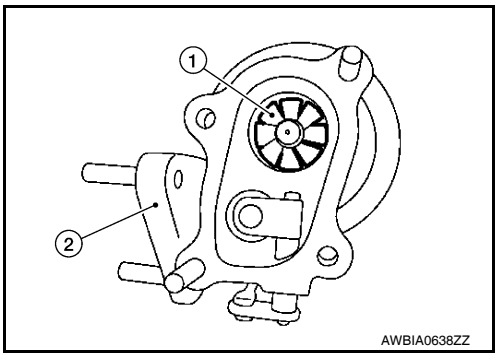
Rotor Shaft End Play

- Place a dial gauge (A) at the rotor shaft (1) end in the axial direction to measure the end play.
- Make sure that the rotor shaft (1) does not interfere with the compressor housing.
- Replace turbocharger if end play or interference with compressor housing is detected.



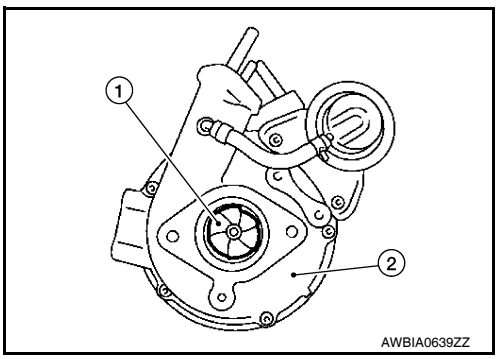
Turbine Wheel

- Make sure that there is no engine oil adhesion.
- Make sure that there is no carbon accumulation.
- Make sure that blades of turbine wheel (1) are not bent or broken.
- Make sure that turbine wheel (1) does not interfere with turbine housing (2).



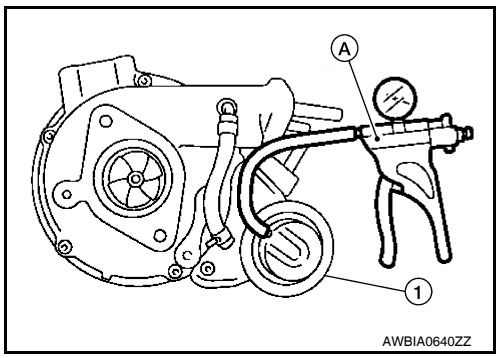
Compressor Wheel

- Make sure that there is no engine oil adhesion inside the air inlet.
- Make sure that compressor wheel (1) does not interfere with compressor housing (2).
- Make sure that compressor wheel (1) is not bent or broken.



Turbocharger Boost Control Actuator

- Connect the handy vacuum pump (A) to the turbocharger boost control actuator (1), and make sure that the rod strokes smoothly in compliance with the following pressure.
- Pressure to be applied at the turbocharger boost control actuator (1) part to move rod end as follows:



Standard (Pressure/rod stroke amount)

: 149.7 to 162.1 kPa (1497 to 1621 mbar, 1122.9 to 1215.9 mmHg, 44.2 to 47.8 inHg)/2.0 mm (0.079 in)

: 172.7 to 187.1 kPa (1727 to 1871 mbar, 1295.4 to 1403.4 mmHg, 51.0 to 55.2 inHg)/4.0 mm (0.157 in)

With identified mark (blue)

: 109.0 to 118.2 kPa (1090 to 1182 mbar, 817.6 to 886.6 mmHg, 32.2 to 34.9 inHg)/2.0 mm (0.079 in)

: 128.2 to 138.8 kPa (1282 to 1388 mbar, 961.6 to 1041.1 mmHg, 37.9 to 41.0 inHg)/4.0 mm (0.157 in)

TROUBLE DIAGNOSIS OF TURBOCHARGER

Preliminary check:

- Make sure that the engine oil level is between MIN and MAX of the oil level gauge. (When engine oil amount is more than MAX, engine oil flows into the inlet duct through blow-by gas passage, and turbocharger is misjudged malfunction.)
- Ask the customer if he/she always runs the vehicle in idle engine speed to cool the engine oil down after driving.
- Replace the turbocharger assembly when any malfunction is found after unit inspections specified in the table below.
- If no malfunction is found after the unit inspections, judge that the turbocharger body has no malfunction. Check the other parts again.

Inspection item	Inspection result	Symptom (when each inspection item meets each inspection result)			
		Engine oil leakage	Smoke	Noise	Insufficient power/acceleration malfunction
Turbine wheel	Engine oil leaks	C	A	C	C
	Carbon is accumulated	C	A	B	B
	Friction with housing	C	B	A	B
	Blades are bent or broken	—	—	A	A
Compressor wheel	Inside the air inlet is seriously contaminated by engine oil.	B	B	—	—
	Friction with housing	C	B	A	B
	Blades are bent or broken	—	—	A	A

Inspection item	Inspection result	Symptom (when each inspection item meets each inspection result)			
		Engine oil leakage	Smoke	Noise	Insufficient power/acceleration malfunction
After checking both turbine and compressor, inspect rotor shaft end play.	There is resistance when the rotor shaft is rotated by your fingertips.	—	C	C	B
	The rotor shaft sometimes does not rotate by your fingertips.	—	—	—	A
	There is too much play in the bearing.	C	C	B	C
Oil return port	Carbon or sludge is accumulated in the waste oil hole.	C	A	C	C

A: Large possibility

B: Medium possibility

C: Small possibility

INSTALLATION

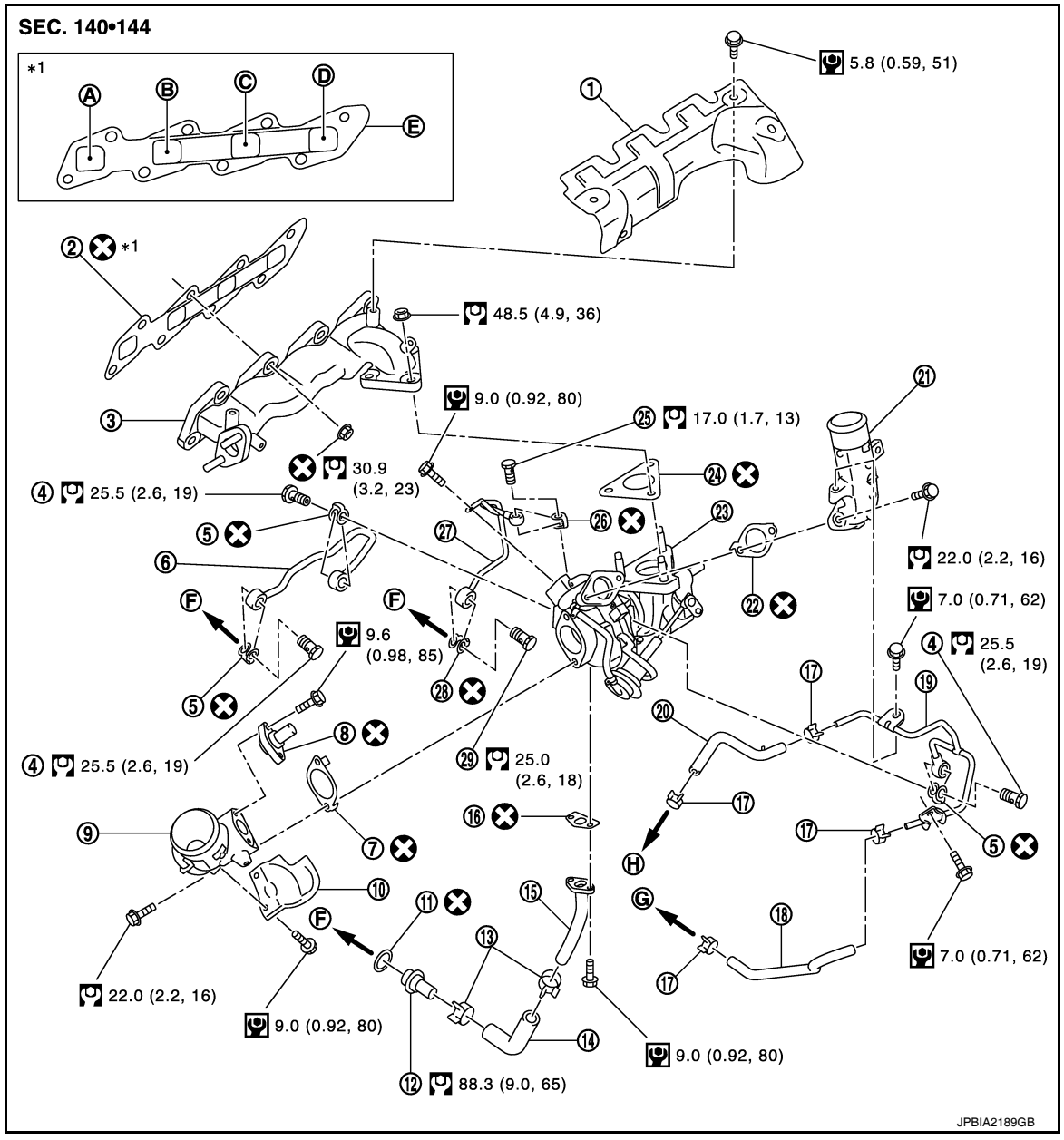
- When a stud bolt is pulled out, replace it with a new one and tighten it to the following torque.

: 25.5 N·m (2.6 kg-m, 19 ft-lb)

EXHAUST MANIFOLD

Component

INFOID:0000000006927514



1. Exhaust manifold cover
2. Gasket
3. Exhaust manifold
4. Eye-bolt
5. Copper washer
6. Water feed pipe
7. Gasket
8. Ventilation hose connector
9. Air inlet tube
10. Insulator
11. Gasket
12. Connector
13. Clamp
14. Oil return hose
15. Oil return tube
16. Gasket
17. Clamp
18. Water hose
19. Water return tube
20. Water hose
21. Air inlet tube
22. Gasket
23. Turbocharger
24. Gasket
25. Eye-bolt
26. Copper washer
27. Oil feed pipe
28. Copper washer
29. Eye-bolt
A. No. 1
B. No. 2
C. No. 3
D. No. 4

E. Alignment protrusion F. To cylinder block G. To heater return pipe
H. To water outlet

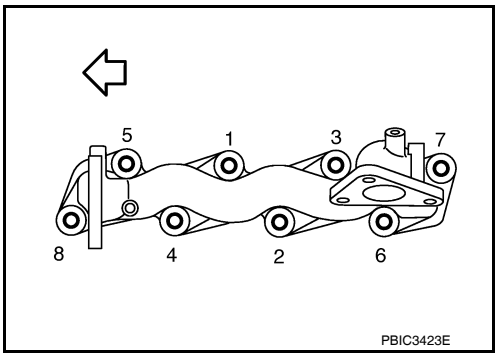
Removal and Installation

INFOID:0000000006927515

REMOVAL

1. Drain engine coolant. Refer to CO-33, "Changing Engine Coolant".
2. Remove air cleaner and air duct. Refer to EM-90, "Component".
3. Remove turbocharger. Refer to EM-100, "Component".
4. Remove EGR tube, if equipped. Refer to EM-93, "Component".
5. Loosen exhaust manifold nuts in the reverse order as shown.

⇦ : Vehicle front



6. Remove exhaust manifold.

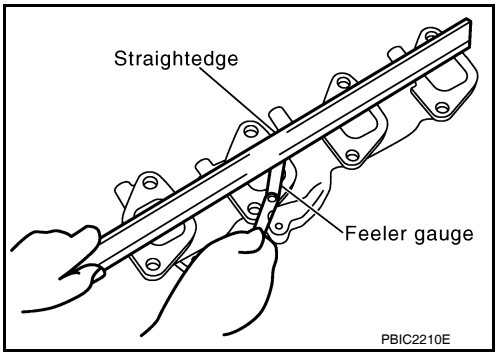
INSPECTION AFTER REMOVAL

Surface Distortion

- Use a reliable straight edge and feeler gauge to check the flatness of exhaust manifold contact surface.

Limit : 0.3 mm (0.012 in)

- If it exceeds the limit, replace exhaust manifold.



INSTALLATION

Installation is in the reverse order of removal.

- If stud bolts were removed, replace them with new ones, and tighten them to specification.

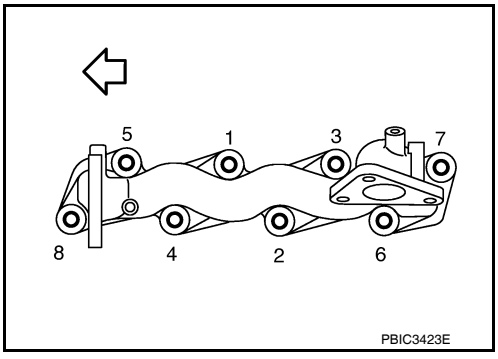
Stud bolts : 14.7 N·m (1.5 kg-m, 11 ft-lb)

- Tighten the exhaust manifold nuts in the following procedure:

1. Install gasket so that the alignment protrusion faces the No. 4 port. Refer to EM-105, "Component".
2. Tighten the exhaust manifold nuts in order as shown.

⇦ : Vehicle front

3. Re-tighten the exhaust manifold nuts.



INSPECTION AFTER INSTALLATION

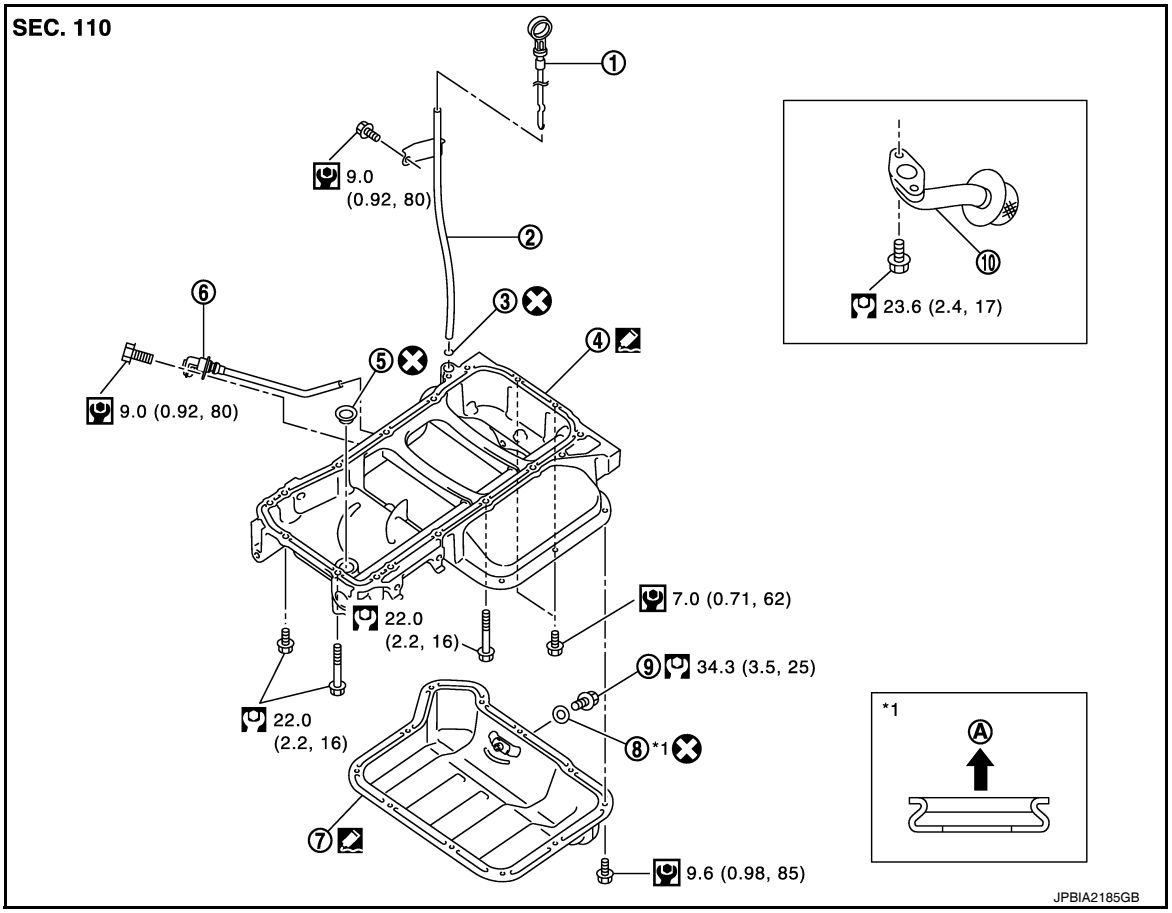
Start engine and raise engine speed to confirm no exhaust gas and engine oil leaks.

OIL PAN AND OIL STRAINER

Component

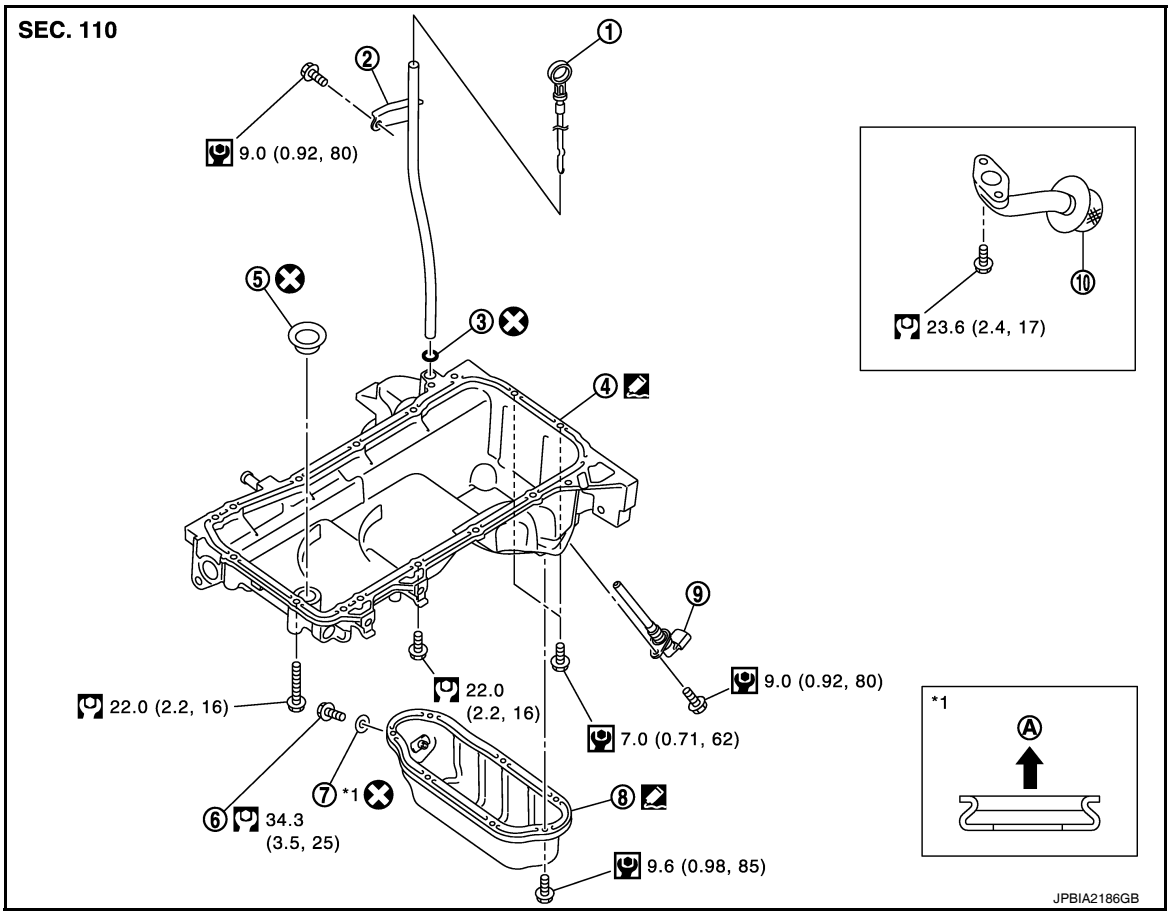
INFOID:0000000006927516

2WD Models



1. Oil level gauge
2. Oil level gauge guide
3. O-ring
4. Oil pan (upper)
5. O-ring
6. Oil level sensor
7. Oil pan (lower)
8. Drain plug washer
9. Oil pan drain plug
10. Oil strainer
A. Oil pan side

4WD Models



1. Oil level gauge
2. Oil level gauge guide
3. O-ring
4. Oil pan (upper)
5. O-ring
6. Oil pan drain plug
7. Drain plug washer
8. Oil pan (lower)
9. Oil level sensor
10. Oil strainer
A. Oil pan side

Removal and Installation

INFOID:0000000006927517

REMOVAL

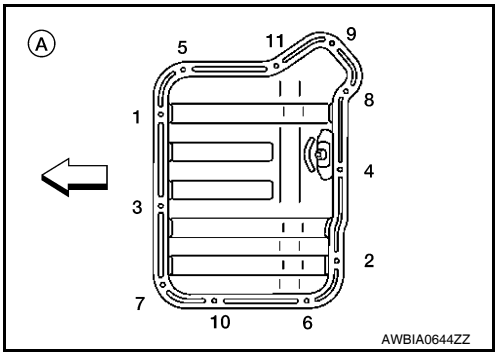
WARNING:

To avoid the danger of being scalded, do not drain engine oil when engine is hot.

1. Remove engine undercover.
2. Drain engine oil. Refer to LU-19, "Changing Engine Oil".
3. Remove oil pan (lower) bolts. Loosen bolts in the reverse order of that shown.

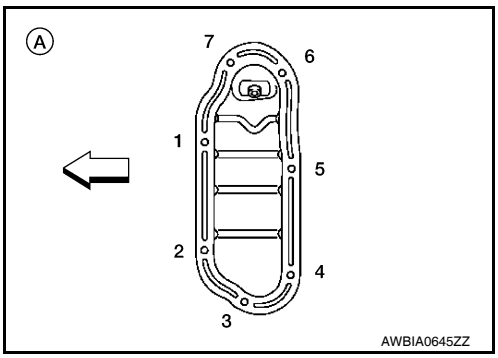
A : 2WD models

⇦ : Front



A : 4WD models

⇦ : Front

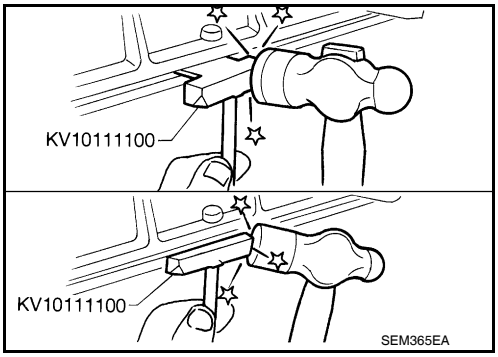


4. Remove oil pan (lower).

a. Insert the seal cutter between oil pan (upper) and oil pan (lower).
CAUTION:
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**

b. Slide the seal cutter by tapping on the side of the seal cutter with a hammer.

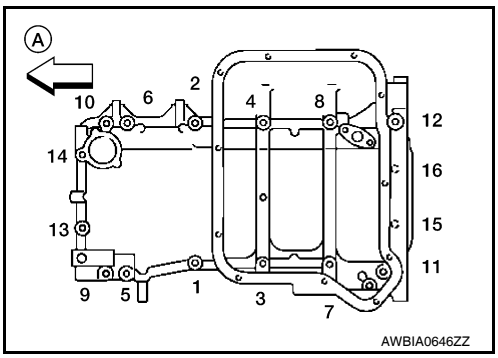
c. Remove oil pan (lower).



5. Remove oil strainer.
6. Remove power steering oil pump belt, if equipped. Refer to EM-88, "Checking Drive Belts".
7. Remove power steering oil pump bracket, if equipped and move power steering oil pump aside with its piping connected. Temporarily secure it on the vehicle side with a rope. Refer to PS-13, "Description".
8. Disconnect oil return hose (vacuum pump) from oil pan (upper). Refer to EM-115, "Component".
9. Remove generator. Refer to SC-22, "Exploded View".
10. Remove A/C compressor bolts and position A/C compressor aside, if equipped. Refer to MTC-68, "Removal and Installation for Compressor".
11. Remove A/C compressor bracket bolts to oil pan (lower).
12. Disconnect left side tie rod end (2WD models). Refer to MS-18, "Component".
13. Remove crankshaft position sensor and oil level sensor.
CAUTION:
- **Avoid impacts such as a dropping.**
- **Do not disassemble.**
- **Keep it away from metal particles.**
- **Do not place sensor close to magnetic materials.**
14. Remove front final drive assembly (4WD models). Refer to FFD-10, "Removal and Installation".
15. Remove transmission joint bolts.
16. Loosen bolts in the reverse order of that shown to remove oil pan (upper).

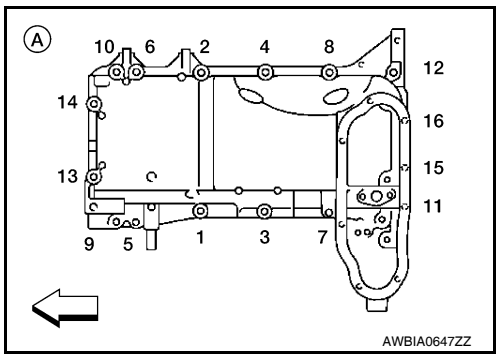
A : 2WD models

⇦ : Vehicle front

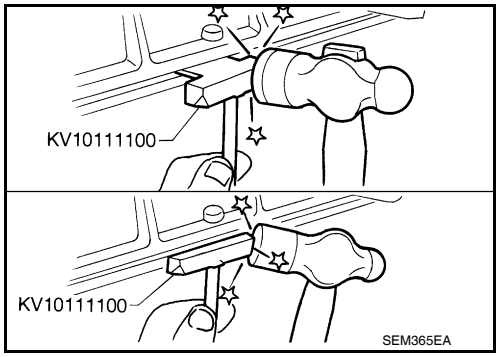


A : 4WD models

⇦ : Vehicle front



17. Remove oil pan (upper).
    - Insert the seal cutter between oil pan (upper) and cylinder block. Slide the seal cutter by tapping on the side of the seal cutter with a hammer. Remove oil pan (upper).
    - **Be careful not to damage aluminum mating surface.**
    - **Do not insert screwdriver, or oil pan flange will be deformed.**



INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

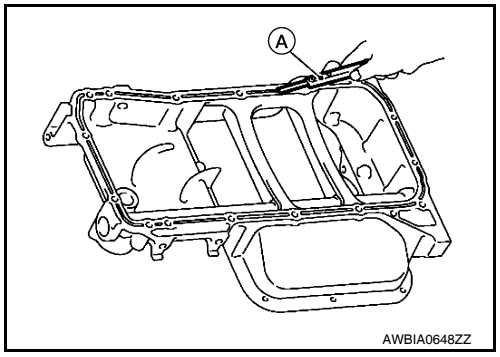
INSTALLATION

Installation is in the reverse order of removal.

- Install oil pan (upper) with the following procedure.

- Use the scraper (A) to remove old liquid gasket from mating surface of oil pan (upper).

- **Also remove old liquid gasket from mating surface of cylinder block and rear chain case.**
- **Remove old liquid gasket from the bolt hole and thread.**



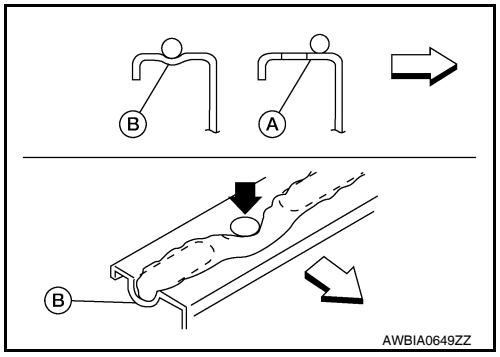
- Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan (upper).

A : Bolt hole

B : Groove

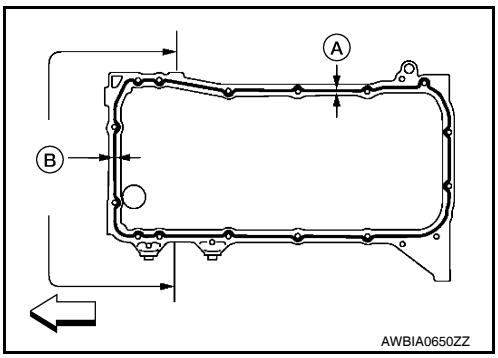
⇦ : Inner side

Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".



CAUTION:

- **Apply liquid gasket to areas shown.**
- **Be sure liquid gasket is applied 3.5 to 4.5 mm (0.138 to 0.177 in) (A) or 4.5 to 5.5 mm (0.177 to 0.217 in) (B) wide as shown. (Be careful that the diameter of the liquid gasket bead is different around the front.)**
- **Installation should be done within 5 minutes after coating.**



- Install oil pan (upper).

CAUTION:

Install avoiding misalignment of O-ring.

- Tighten bolts in numerical order as shown to specification.

A : 2WD models

⇦ : Front

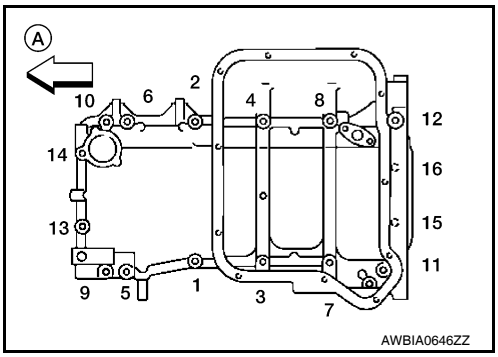
- Bolt dimensions vary depending on the installation location. Use the dimensions following to select appropriate bolts.

M6 x 12 mm (0.47 in) : Bolt No. 11, 14

M6 x 30 mm (1.18 in) : Bolt No. 15, 16

M8 x 25 mm (0.98 in) : Bolt No. 1, 5, 9, 13

M8 x 60 mm (2.36 in) : Bolt No. 2, 3, 4, 6, 7, 8, 10, 12



- The shank length under the bolt neck above is the length of the threaded part (pilot portion not included).

- Tighten bolts in numerical order as shown to specification.

A :4WD models

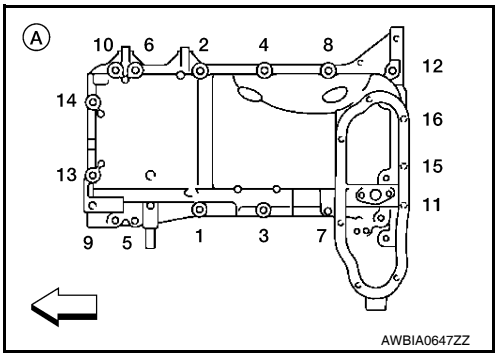
⇦ : Front

- Bolt dimensions vary depending on the installation location. Use the dimensions following to select appropriate bolts.

M6 x 30 mm (1.18 in) : Bolt No. 15, 16

M8 x 25 mm (0.98 in) : Bolt No. 1, 2, 4, 5, 8, 9

M8 x 60 mm (2.36 in) : Bolt No. 3, 6, 7, 10, 11, 12, 13, 14



- The shank length under the bolt neck above is the length of the threaded part (pilot portion not included).

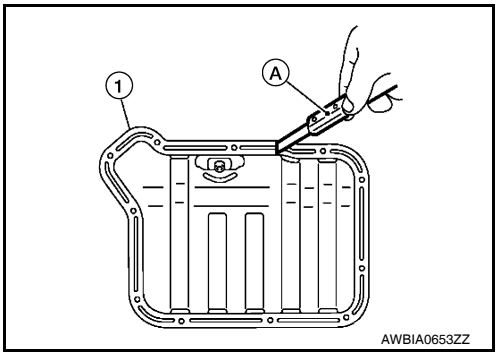
- Install oil pan (lower) with the following procedure.
- Use a scraper (A) to remove old liquid gasket from mating surface of oil pan (lower) (1).

CAUTION:

- **Also remove old liquid gasket from mating surface of oil pan (upper).**
- **Remove old liquid gasket from bolt hole and thread.**

NOTE:

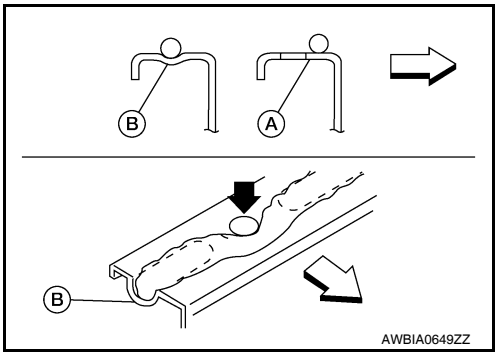
2WD oil pan (lower) shown, 4WD similar.



- Apply a continuous bead of liquid gasket to mating surface of oil pan (lower).

A : Bolt hole
B : Groove
⇦ :Inner side

Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".

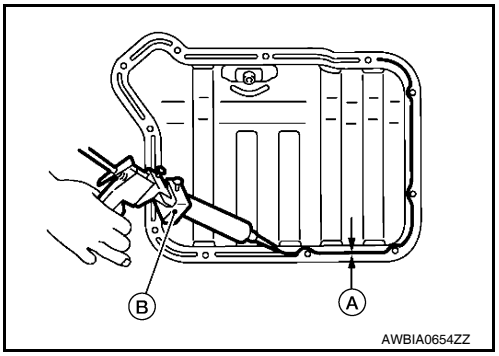


- **Use Tool (B) to apply liquid gasket 3.5 to 4.5 mm (0.138 to 0.177 in) (A) wide.**

Tool number : WS39930000

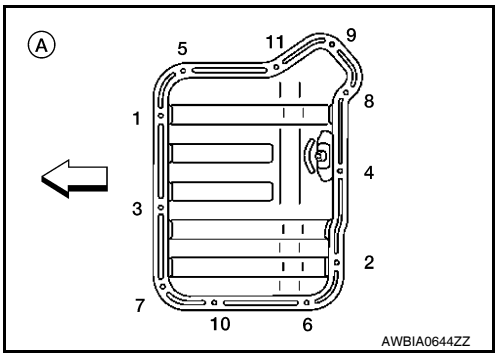
- **Installation should be done within 5 minutes after coating.**

NOTE:
2WD oil pan (lower) shown, 4WD similar.



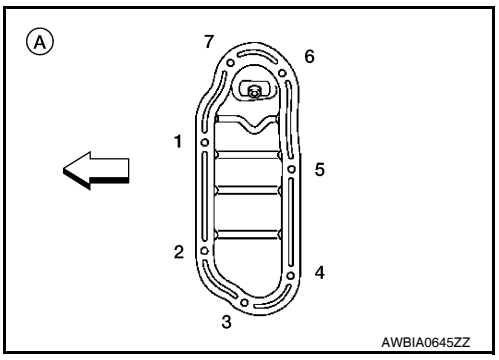
- Install oil pan (lower).
- Tighten bolts in numerical order as shown to specification.

A : 2WD models
⇦ : Front



A : 4WD models
⇦ : Front

NOTE:
Wait at least 30 minutes before refilling engine oil.



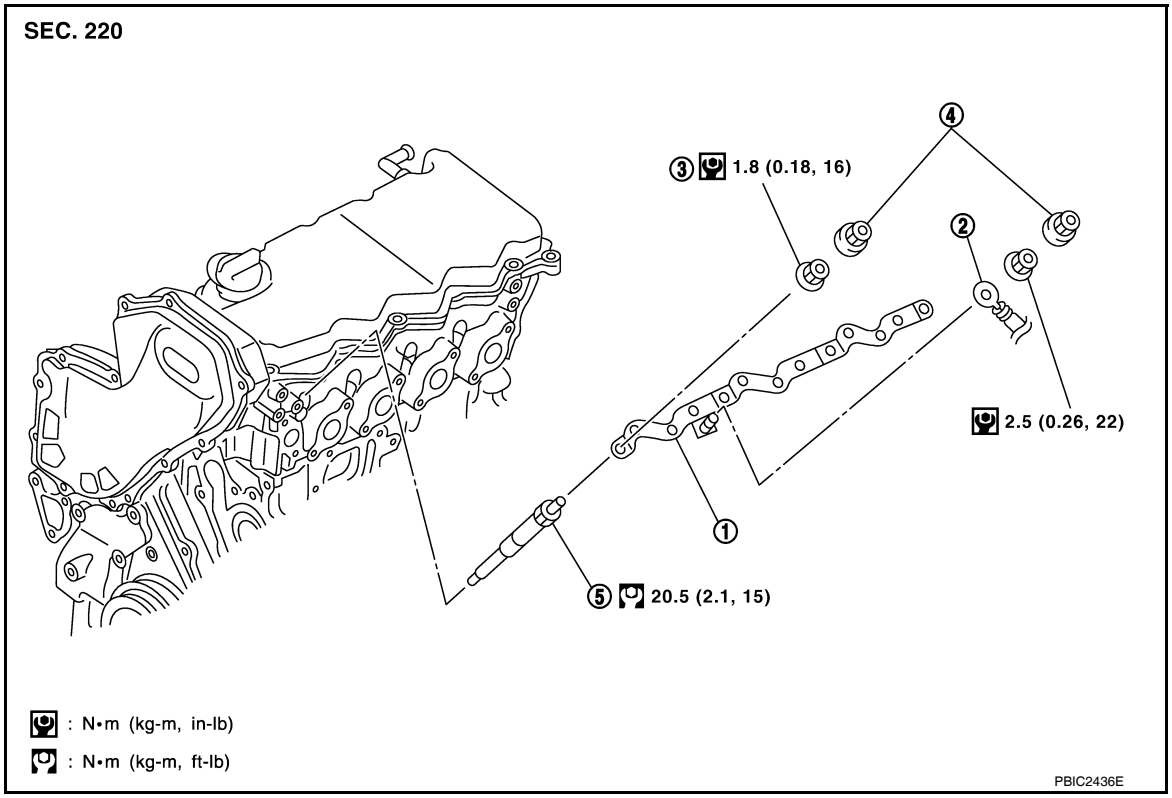
INSPECTION AFTER INSTALLATION

1. Check engine oil level and add engine oil. Refer to LU-18, "Inspection".
2. Check for leakage of engine oil when engine is warmed.
3. Stop engine and wait for 10 minutes.
4. Check engine oil level again. Refer to LU-18, "Inspection".

GLOW PLUG

Component

INFOID:0000000006927518



1. Glow plate
2. Glow harness
3. Glow nut
4. Cap
5. Glow plug

Removal and Installation

INFOID:0000000006927519

REMOVAL

CAUTION:

Remove glow plug only if necessary. If carbon adheres, it may be stuck and broken.

1. Disconnect glow harness from glow plate.
2. Remove glow nut to remove glow plate.
3. Remove glow plug.
   CAUTION:
   - **When removing or installing, do not use such tools as an air impact wrench.**
   - **Handle it carefully without giving any impact, even after removal. [As a guide, if it drops from height of 10 cm (3.94 in) or higher, always replace it.]**

INSTALLATION

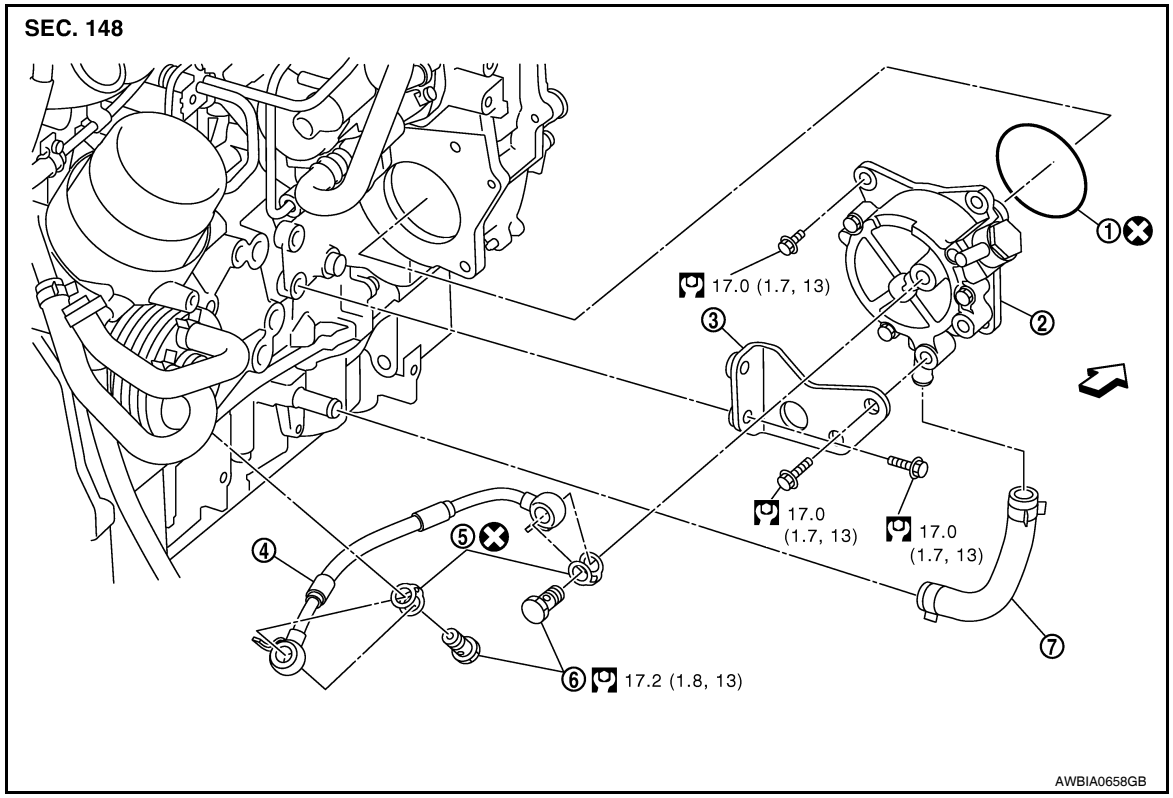
Installation is in the reverse order of removal.

- Remove adhered carbon from glow plug installation hole with a reamer.

VACUUM PUMP

Component

INFOID:0000000006927520



1. O-ring
2. Vacuum pump
3. Bracket
4. Oil feed tube
5. Copper washer
6. Eye-bolt
7. Oil return hose
⇦ Front

Removal and Installation

INFOID:0000000006927521

INSPECTION BEFORE REMOVAL

1. Disconnect vacuum hose, and connect a vacuum gauge via 3-way connector.
   - Disconnect point where vacuum from vacuum pump can be measured directly and install 3-way connector.
2. Start engine and measure generated vacuum at idle speed.

Standard:

–94.0 to – 96.1 kPa (– 940 to – 961 mbar, – 705 to – 721 mmHg, – 27.76 to – 28.38 inHg)

- If out of standard, check for air suction in vacuum route, and measure again.
- If still outside of standard, replace vacuum pump.

REMOVAL

1. Drain engine oil. Refer to LU-19, "Changing Engine Oil".
2. Remove primary timing chain. Refer to EM-153, "Removal and Installation".
3. Disconnect vacuum hose from vacuum pump side.
4. Remove oil feed tube and oil return hose.
5. Remove bracket.
6. Remove vacuum pump and O-ring.

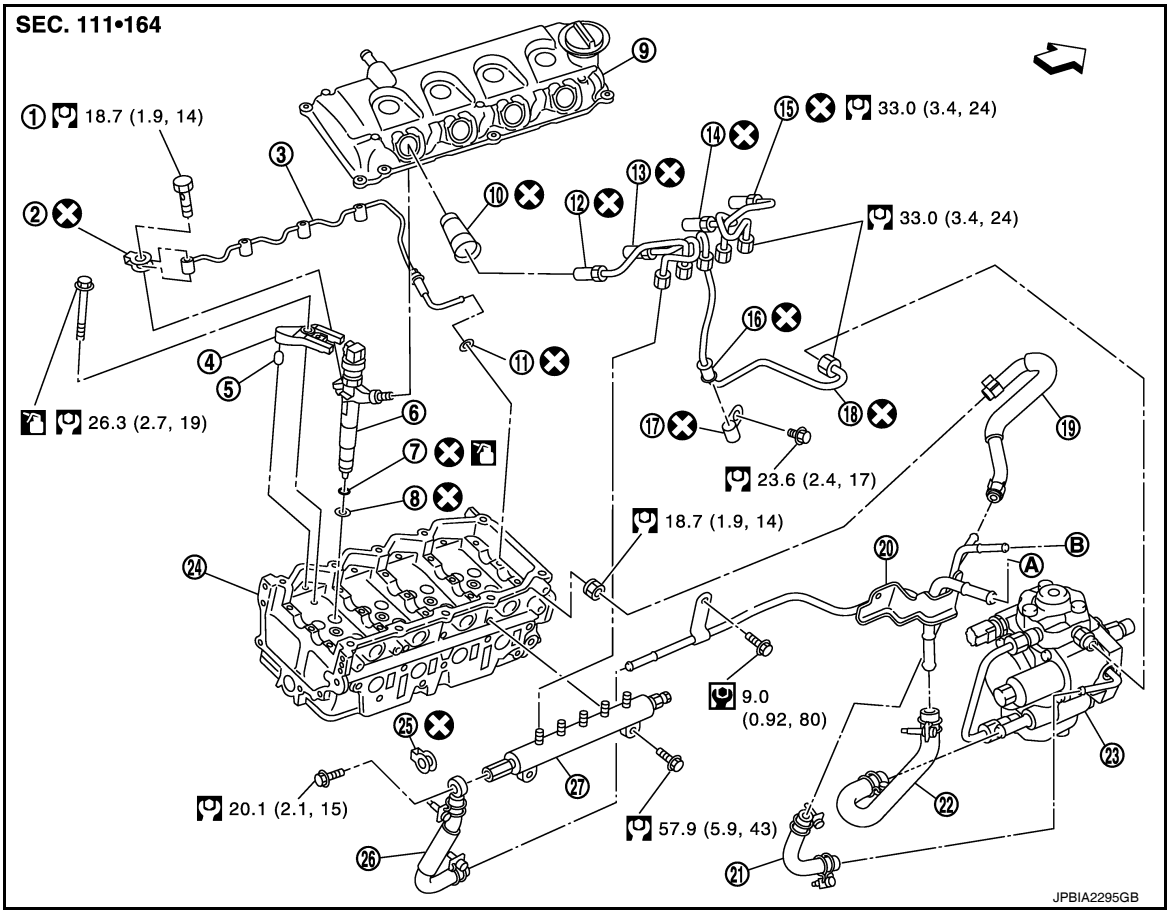
INSTALLATION

Installation is in the reverse order of removal.

INJECTION TUBE AND FUEL INJECTOR

Component

INFOID:0000000006927522



1. Eye-bolt	2. Copper washer	3. Spill tube
4. Nozzle support	5. Pin	6. Fuel injector
7. O-ring	8. Nozzle gasket	9. Rocker cover
10. Nozzle oil seal	11. Washer	12. Injection tube No. 4
13. Injection tube No. 3	14. Injection tube No. 2	15. Injection tube No. 1
16. Insert rubber	17. Clip	18. Injection tube center
19. Spill hose	20. Fuel gallery	21. Spill hose
22. Fuel hose	23. Fuel pump	24. Cylinder head
25. Copper washer	26. Fuel hose	27. Fuel rail
A. To fuel filter	B. To fuel cooler (under floor)	⇦ Front

Removal and Installation

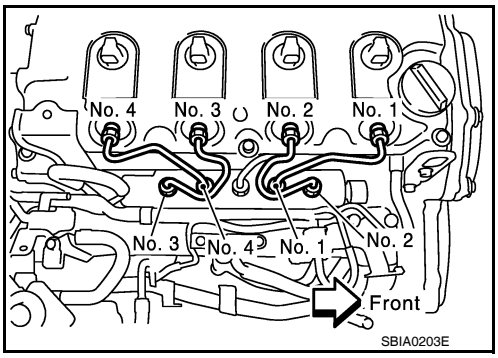
INFOID:0000000006927523

REMOVAL

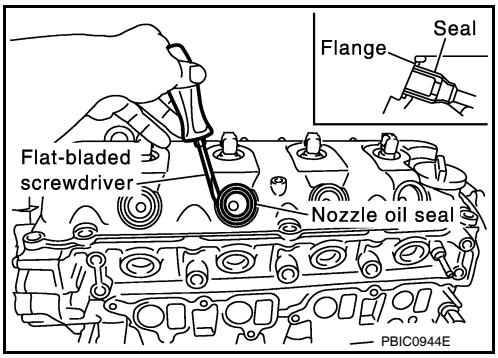
1. Remove charge air cooler. Refer to EM-92, "Removal and Installation".
2. Remove intake manifold. Refer to EM-95, "Removal and Installation".
3. Disconnect harness connector from fuel injectors.
4. Remove spill hose.
   CAUTION:
   - **Do not spill fuel in engine room.**
   - **Do not spill fuel on engine mounting insulator.**
5. Following steps below, remove injection tubes.

a. Put a paint mark or tag on injection tubes to identify each cylinder.
   • Use a fuel-resistant method.

b. Remove injection tubes in order of 2-1-4-3 individually.
   CAUTION:
   • **Do not spill fuel in engine room.**
   • **Do not spill fuel on engine mounting insulator.**

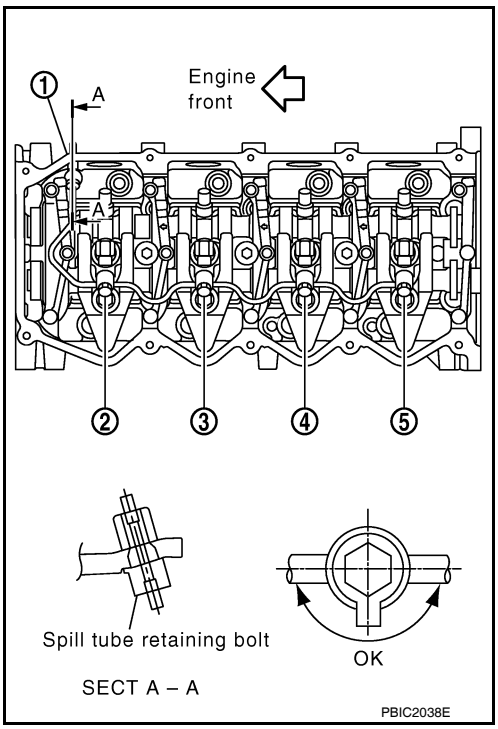


6. Remove nozzle oil seal.
   • Using a suitable tool, pry flange to remove oil seal.
   NOTE:
   Nozzle oil seal seals between fuel injector and rocker cover. If only injection tube shall be removed and installed, nozzle oil seal replacement is not required.



7. Remove rocker cover. Refer to EM-129, "Component".

8. Remove spill tube bolts and nut.
   • Loosen bolts and nut in the reverse order as shown and remove them.
   CAUTION:
   When loosening nut, secure spill tube retaining bolt with suitable tool.



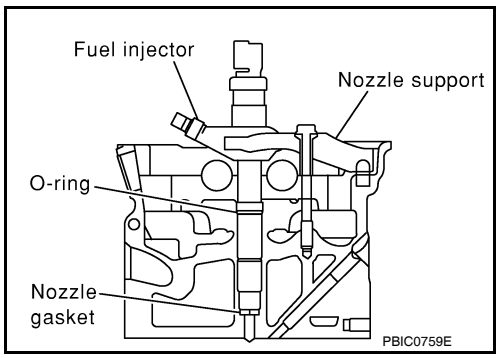
9. Following steps below, remove fuel injector.

a. Remove nozzle support.

b. Remove fuel injector. While rotating it to left and right, raise it to remove.
CAUTION:
- **Handle fuel injector carefully without giving any impact.**
- **Do not disassemble fuel injector.**

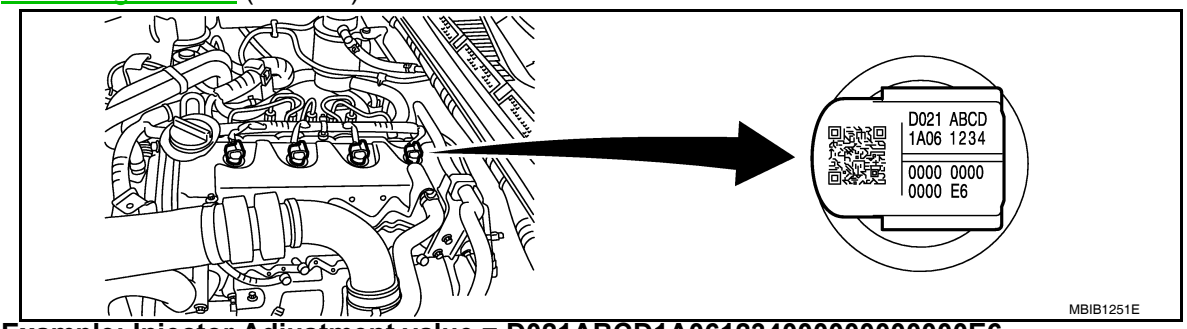
c. If nozzle gasket remains in cylinder head, hook it with a suitable tool and pull it out.

d. Remove O-ring from fuel injector.



INSTALLATION

1. Record INJECTOR ADJUSTMENT VALUE on the top surface when replacing fuel injector.
   - Refer to EC-482, "Injector Adjustment Value Registration" (TYPE 1) or EC-727, "Injector Adjustment Value Registration" (TYPE 2) for use of INJECTOR ADJUSTMENT VALUE.



Example: Injector Adjustment value = D021ABCD1A06123400000000000E6

2. Following steps below, install fuel injector.

a. Install O-ring and nozzle gasket to fuel injector, and insert them into cylinder head.

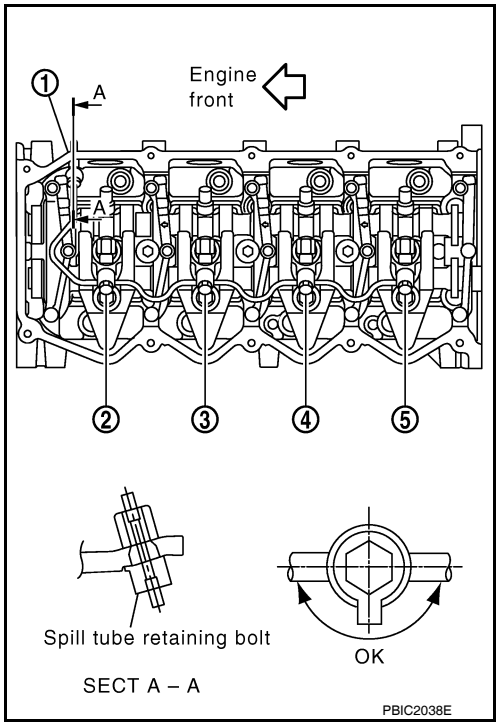
b. Tighten injection tubes temporarily in the order of 3-4-1-2.

c. Be sure to fit nozzle support and pin securely.

d. Tighten nozzle support bolts.

e. Loosen injection tubes in the order of 2-1-4-3.

3. Connect spill tube.
   - Tighten spill tube bolts and nut in numerical order as shown.
   CAUTION:
   When tightening nut, secure spill tube retaining bolt with suitable tool.
   NOTE:
   Connection of spill tube copper washer may be broken, even if it is tighten to the specified torque. It does not affect performance.

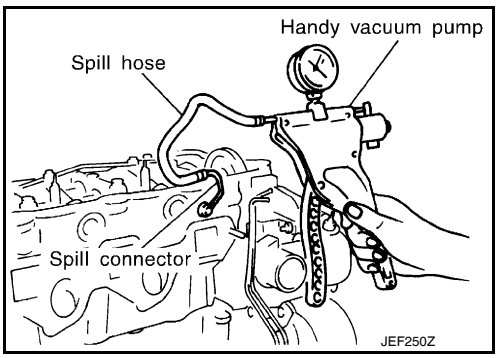


4. Perform air tightness test for spill tube.
   - Connect a handy vacuum pump to spill connector. Make sure that vacuum is retained while applying following vacuum.

     Standard:

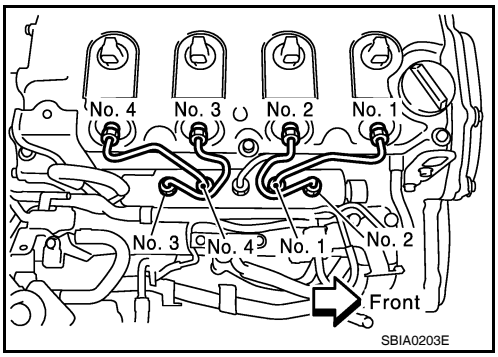
     – 53.3 to – 66.7 kPa (– 533 to – 667 mbar, – 400 to – 500 mmHg, – 15.75 to – 19.69 inHg)

   - If outside of standard, reinstall spill tube. (Replace copper washer in this case.)

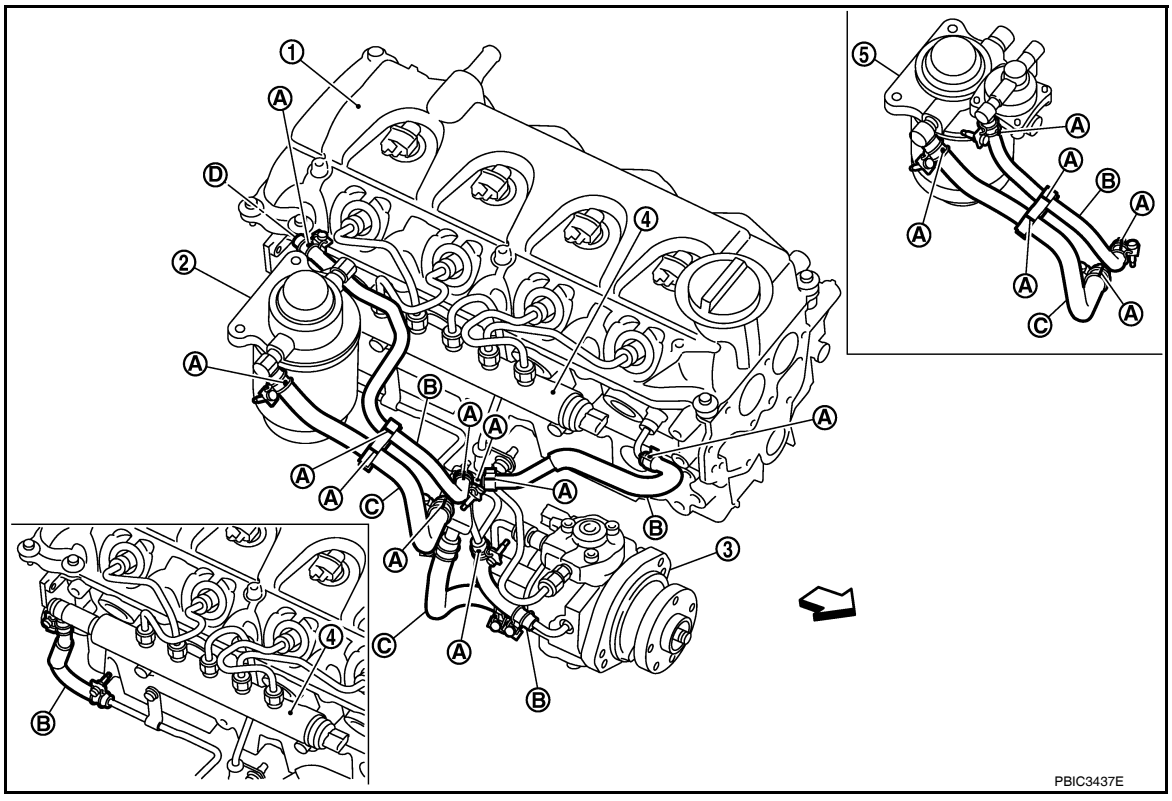


5. Install rocker cover. Refer to EM-129, "Removal and Installation".
6. Install nozzle oil seal.
   - Insert it straight until its flange fully contacts rocker cover.

   CAUTION:
   - **Check gutter spring in nozzle oil seal on fuel injector.**
7. Connect injection tubes individually to each cylinder in order of 3-4-1-2.



8. Install fuel hoses, spill hose and fuel gallery as shown.



1. Rocker cover
2. Fuel filter (standard models)
3. Fuel pump
4. Fuel rail
5. Fuel filter

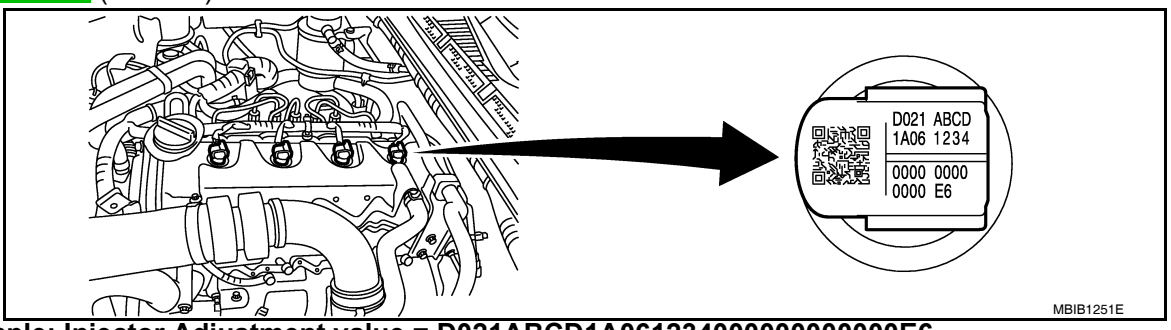
A. Align paint mark
B. Insert the hose up to 26 mm (1.02 in)
C. Insert the hose up to 28 mm (1.10 in)
D. To fuel cooler (under floor)
⇦ Front

NOTE:
Intake manifold and other related parts are omitted for explanation.

9. Installation of remaining parts is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

- Input INJECTOR ADJUSTMENT VALUE to ECM after installing to the vehicle when replacing fuel injector. Refer to EC-482, "Injector Adjustment Value Registration" (TYPE 1) or EC-727, "Injector Adjustment Value Registration" (TYPE 2).



Example: Injector Adjustment value = D021ABCD1A06123400000000000E6

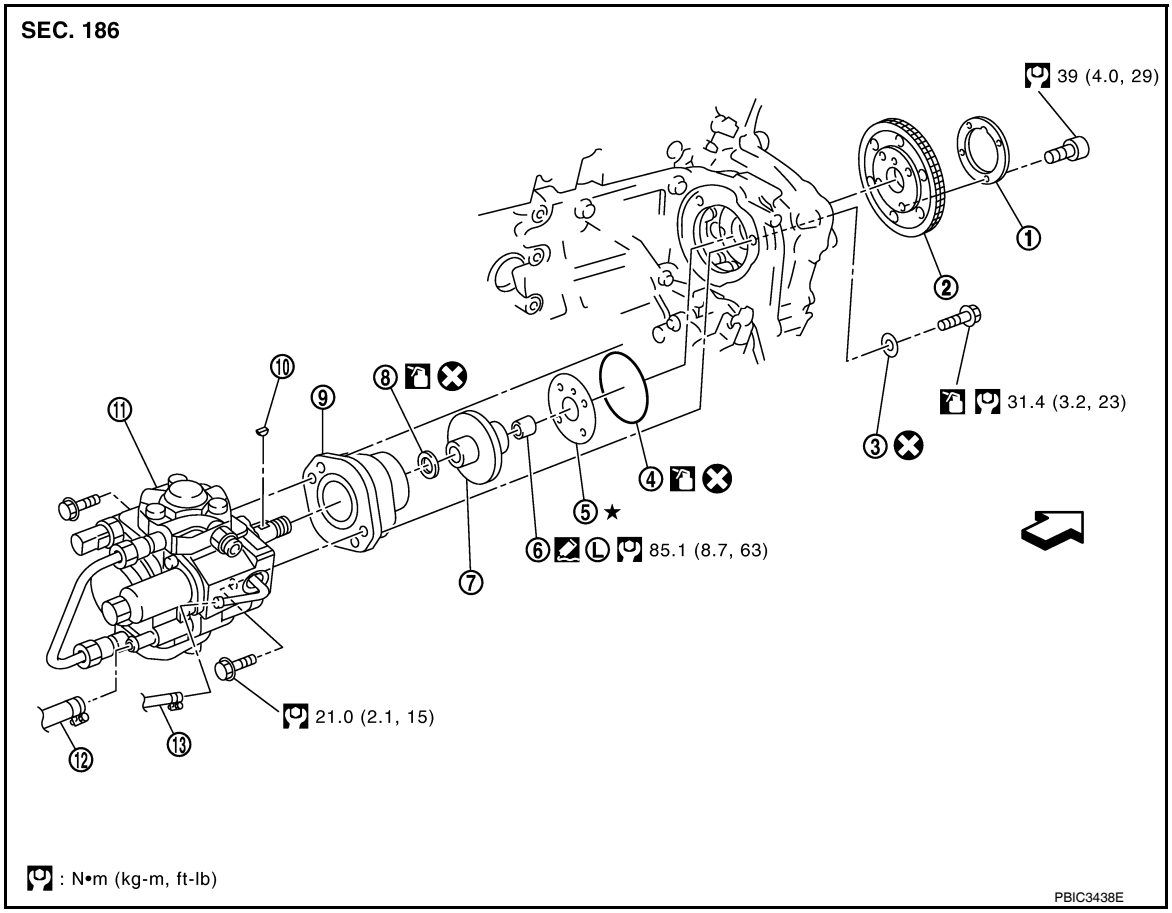
- Start engine and increase engine speed to check for fuel leak.

CAUTION:
Do not touch engine immediately after stopped as engine becomes extremely hot.

FUEL PUMP

Component

INFOID:0000000006927524



1.	Washer	2.	Fuel pump sprocket	3.	Seal washer
4.	O-ring	5.	Adjusting shim	6.	Sprocket nut
7.	Coupling	8.	Oil seal	9.	Spacer
10.	Key	11.	Fuel pump	12.	Fuel hose
13.	Spill hose	⇦	Front		

Removal and Installation

INFOID:0000000006927525

CAUTION:

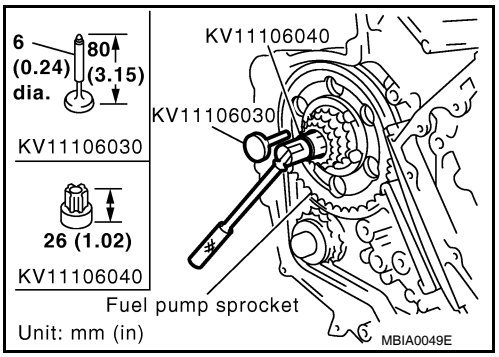
- **Before removing and installing fuel pump, be sure to remove sprocket. Do not loosen or remove installation nut in the center of fuel pump. If loosened or removed, replace fuel pump.**
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **When fuel pump is replaced with new one or another one, perform fuel pump learning value clearing before starting engine. Refer to EC-483, "Fuel Pump Learning Value Clearing".**

REMOVAL

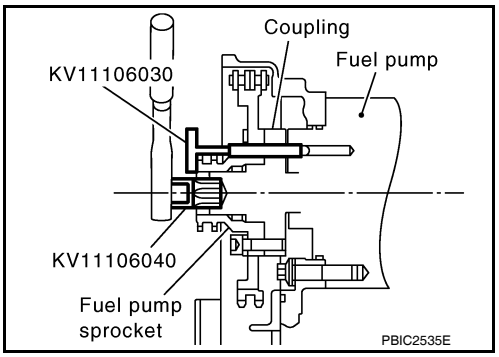
1. Remove heater feed pipe. Refer to CO-42, "Component".
2. Remove fuel hose and spill hose from fuel pump. Refer to EM-117, "Component".
   CAUTION:
   Do not spill fuel in the engine component.
3. Disconnect harness connectors from fuel pump.

4. Remove injection tube center, clip and insert rubber. Refer to EM-117, "Component".
CAUTION:
Do not spill fuel in the engine component.

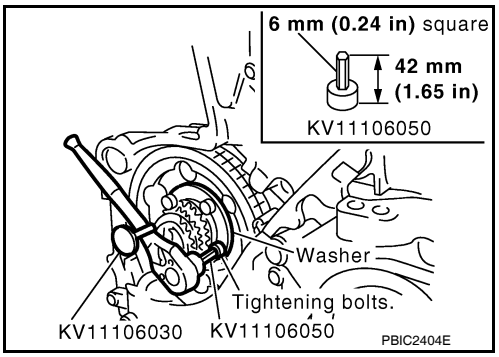
5. Remove secondary timing chain. Refer to EM-146, "Component".
6. Hold fuel pump sprocket and remove bolt.
a. Insert the positioning stopper pin into the hole 6 mm (0.24 in) in the diameter on the fuel pump sprocket.
b. Using the TORX wrench, turn pump shaft little by little to adjust the position of fuel pump sprocket so that the holes align.
c. Push the positioning stopper pin through fuel pump sprocket to fuel pump body to hold fuel pump sprocket.

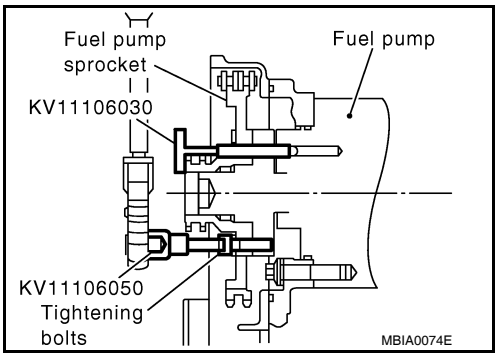


- Insert the positioning stopper pin until its flange contacts the fuel pump sprocket.

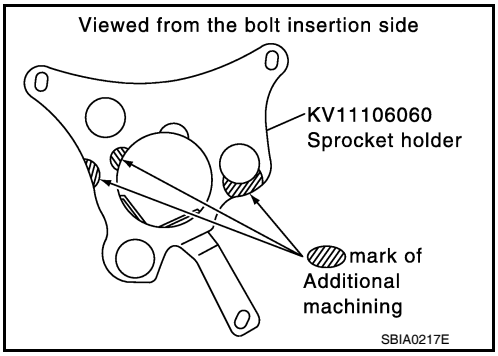


7. Using the hexagon wrench remove tightening bolts of fuel pump sprocket.





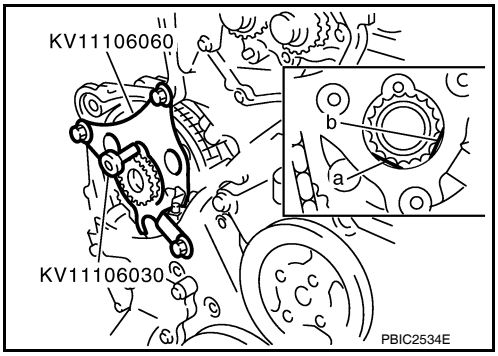
8. Using the sprocket holder, hold fuel pump sprocket to prevent falling.
   - For sprocket holder, use KV11106060 machined as shown, because the previous bore is not fitting.

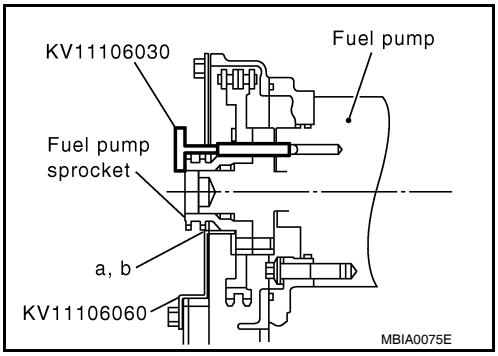


   - When the sprocket holder is installed, if the positioning stopper pin interferes, pull out the positioning stopper pin approximately 10 mm (0.39 in), then install it.
   - After the sprocket holder is installed temporarily, tighten the sprocket holder after making extension bar and TORX socket (size: E10) insert into the machined bore.
   - The length of the sprocket holder bolts should be approximately 15 mm (0.59 in) (M6 thread length).
   - Make sure that the a- and b-faces of the sprocket holder contact the bottom side of the sprocket (small diameter side).

     CAUTION:

     Do not remove the sprocket holder until fuel pump is installed.
   - After the sprocket holder is installed, pull out the positioning stopper pin from fuel pump sprocket.

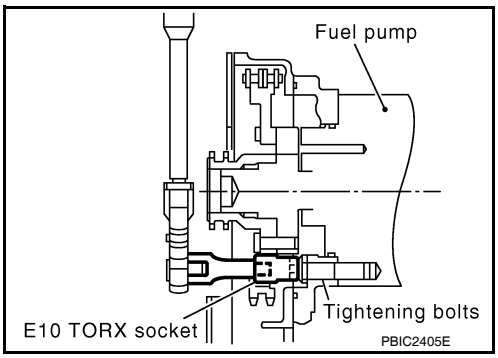




9. Using the extension bar and the TORX socket (size: E10), remove the bolts.

   CAUTION:

   Do not disassemble or adjust fuel pump.



10. Remove the fuel pump toward the rear of engine.

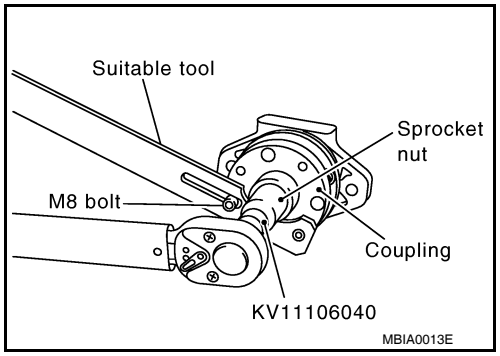
    CAUTION:

    For removal, be careful not to drop the seal washer into the engine.

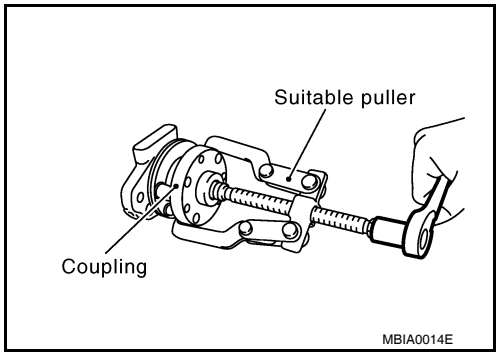
    NOTE:

    The seal washer of the bolts cannot be reused.
11. Remove adjusting shim.
12. Attach a suitable tool in the M8 bolt hole on coupling.

13. Loosen sprocket nut with the TORX wrench.



14. Remove coupling with a suitable puller.

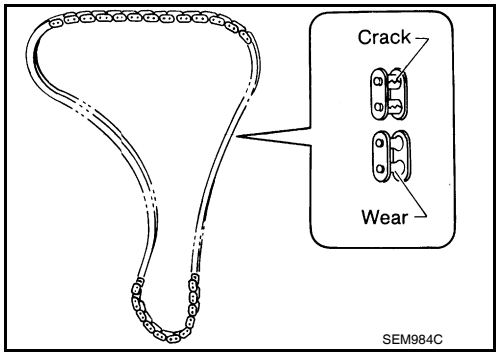


15. Remove spacer from fuel pump.
16. Remove oil seal from spacer.

INSPECTION AFTER REMOVAL

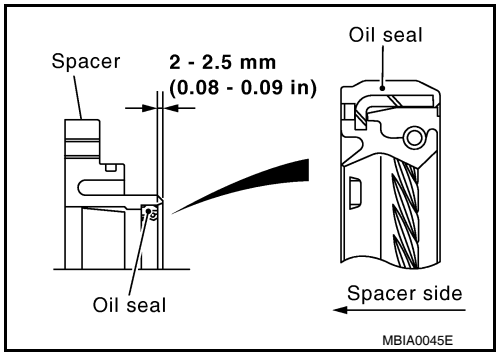
Timing Chain

Check for cracks and excessive wear at roller links. Replace timing chain if necessary.



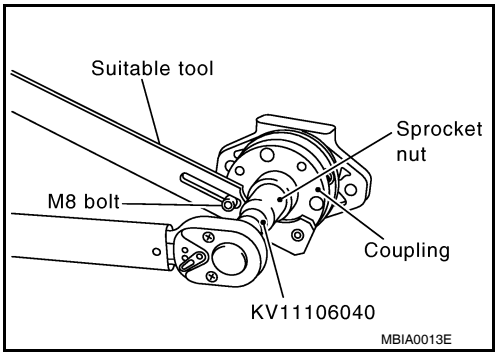
INSTALLATION

1. Install new oil seal to spacer.

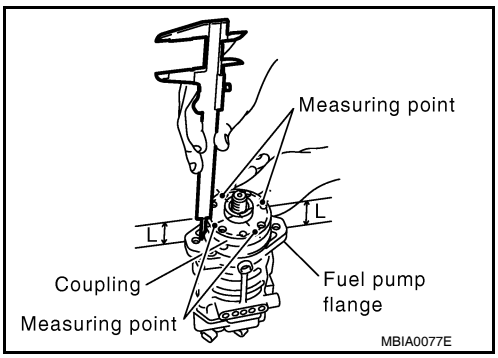


2. Install spacer to fuel pump.

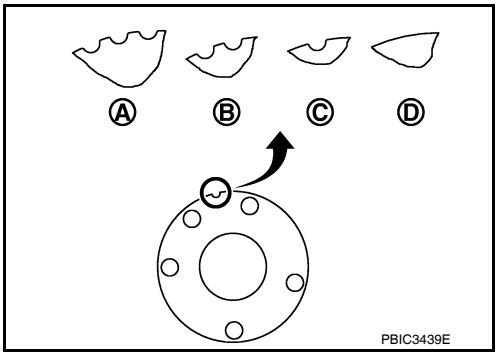
3. Install coupling to fuel pump of spacer.
   • Using the Tool to tighten the sprocket nut to fix the coupling.



4. Install adjusting shim.
   • For shim adjustment, measure dimension L [Distance between front surface of coupling and the fuel pump flange (spacer)] at two opposing points near the coupling bolt center. Use the average of these two measurements to select the shim grade that marked on adjusting shim.



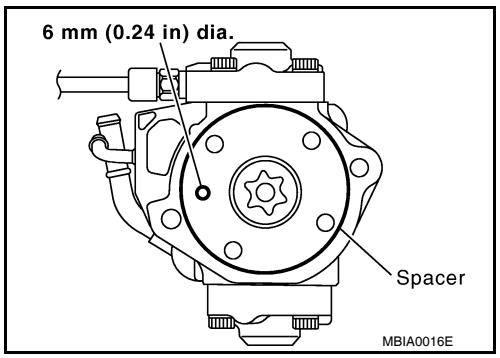
   • The shim adjustment is required only when the fuel pump is replaced.



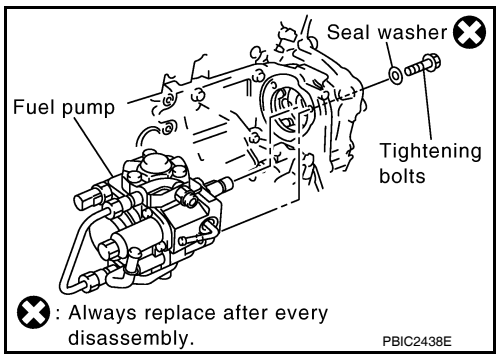
Part No. of adjusting shim*	Grade number	Measuring dimension L mm (in)	Type
16614 8H800	0.5 t	39.23 - 39.77 (1.5445 - 1.5657)	A
16614 8H810	1.0 t	38.76 - 39.23 (1.5260 - 1.5445)	B
16614 8H860	1.2 t	38.57 - 38.76 (1.5185 - 1.5260)	C
16614 8H820	1.6 t	38.18 - 38.57 (1.5031 - 1.5185)	D
16614 8H800 + 16614 8H860	0.5 t + 1.2 t	38.09 - 38.18 (1.4996 - 1.5031)	A + C
16614 8H810 + 16614 8H810	1.0 t + 1.0 t	37.80 - 38.09 (1.4882 - 1.4996)	B + B
16614 8H860 + 16614 8H810	1.2 t + 1.0 t	37.60 - 37.80 (1.4803 - 1.4882)	C + B
16614 8H820 + 16614 8H810	1.6 t + 1.0 t	37.21 - 37.60 (1.4650 - 1.4803)	D + B

*: Always check with the Parts Department for the latest parts information

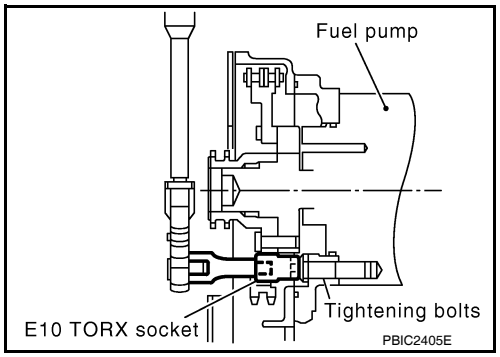
5. Before fuel pump is installed, make sure that spacer and the 6 mm (0.24 in) dia. hole on coupling are aligned.



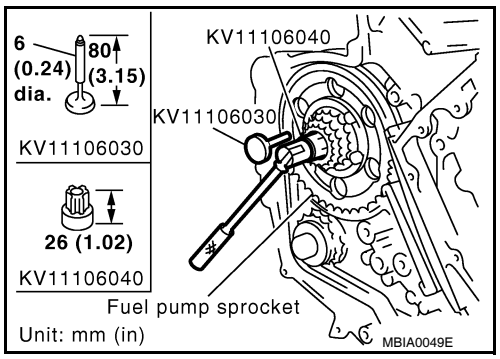
6. Insert fuel pump to the mounting position from the rear side of the engine, and install the bolts with seal washer.
CAUTION:
Be careful not to drop the seal washer into engine.



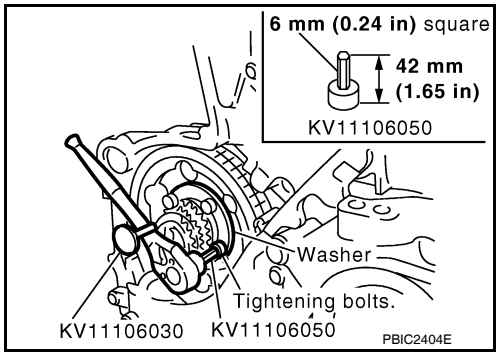
7. Using the extension bar and the TORX socket (size: E10), tighten the tightening bolts of fuel pump.
8. Remove the sprocket holder.



9. Using the TORX wrench, turn the pump shaft gradually to adjust the position of fuel pump sprocket. Then, insert the positioning stopper pin to the 6 mm (0.24 in) dia. hole of the fuel pump sprocket through the pump body.
10. Remove the TORX wrench.



11. Using the hexagon wrench, tighten the sprocket tightening bolt.
    - When the washer of the fuel pump sprocket is removed, install it with the marking “F” (front) facing the front of the engine.
12. Pull out the positioning stopper pin.



13. Install secondary timing chain. Refer to EM-146, "Component".
14. Following steps below, install injection tube center. Refer to EM-117.

a. Pre-set clip and insert rubber to injection tube center.
b. Pre-tight nut of injection tube center to fuel pump and fuel rail by hand. (until seal surface touched)
c. Adjust clip dimension and tighten bolt for clip to intake manifold using suitable tool.
d. Tighten nut of injection tube center to fuel pump using suitable tool.
e. Tighten nut of injection tube center to fuel rail using suitable tool.

15. Connect the harness connector to fuel pump.
16. Install fuel hoses. Refer to EM-117, "Component".
17. Installation of the remaining parts is in the reverse order of removal.

CAUTION:
When fuel pump is replaced with new one or another one, perform fuel pump learning value clearing before starting engine. Refer to EC-483, "Fuel Pump Learning Value Clearing".

ROCKER COVER

Component

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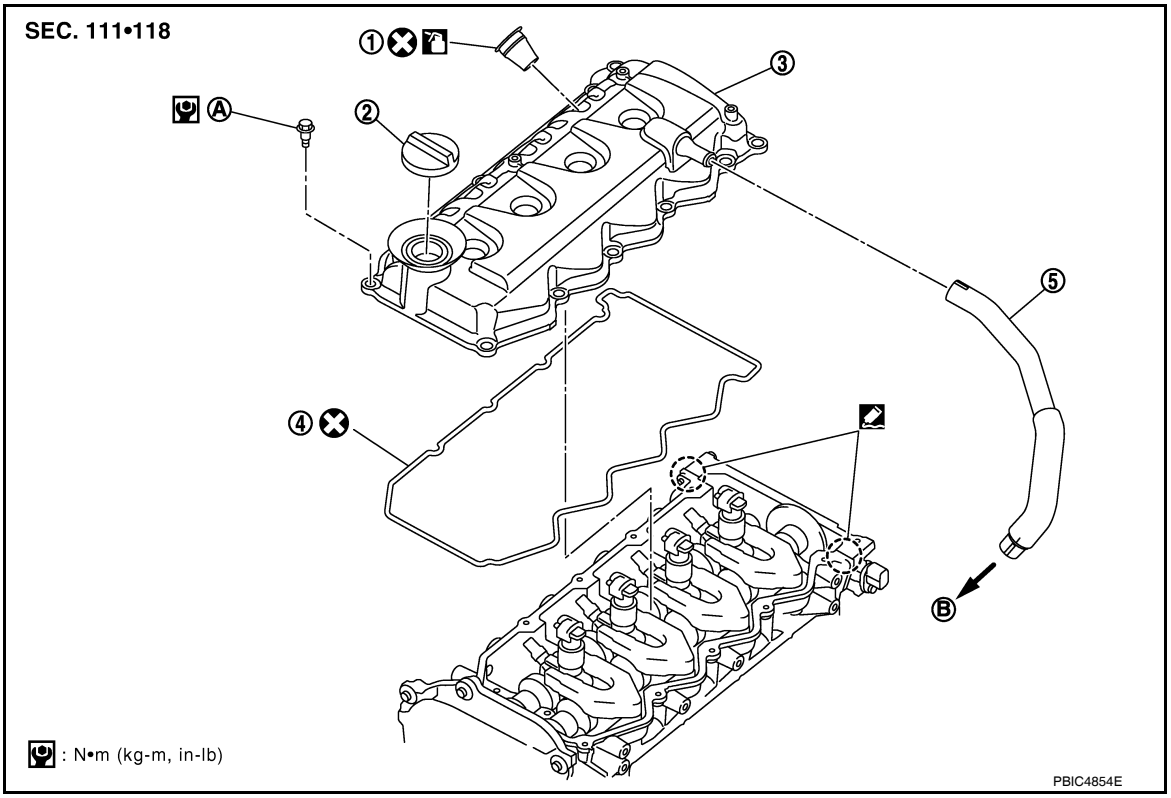


1. Nozzle oil seal
2. Oil filler cap
3. Rocker cover
4. Gasket
5. Ventilation hose
A. Refer to EM-129
B. To ventilation hose connector

Removal and Installation

INFOID:0000000006927527

REMOVAL

1. Remove charge air cooler. Refer to EM-92, "Removal and Installation".
2. Remove vacuum gallery and ventilation hose. Refer to EM-93, "Component" and EM-90, "Component".
3. Disconnect harness connector from fuel injector. Refer to EM-117, "Component".
4. Following steps below, remove injection tube. Refer to EM-117, "Component".

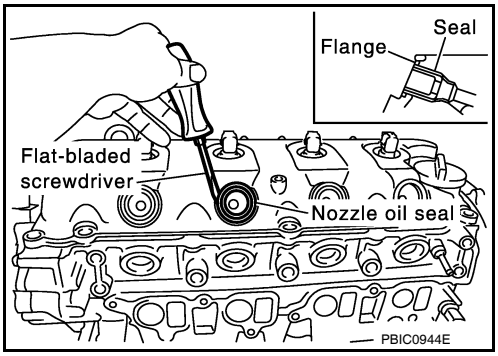
a. Put a paint mark or tag on injection tubes to identify each cylinder.
- Use a fuel-resistant method.

b. Remove injection tubes in order of 2-1-4-3 individually.

CAUTION:
- **Do not allow leaked fuel to contaminate engine room.**
- **Do not spill fuel on engine mounting insulator.**

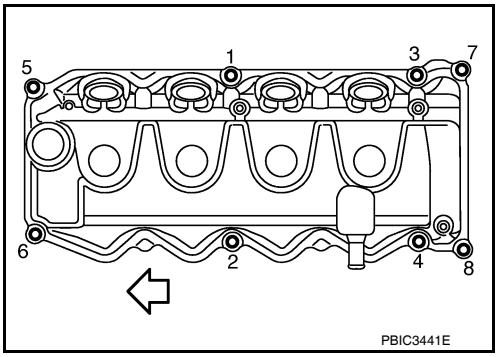
5. Remove injection nozzle oil seal.

• Using the suitable tool, pry flange to remove nozzle oil seal.



6. Remove rocker cover.
   • Loosen bolts in the reverse order of that shown and remove.

   ⇦ : Front



7. Remove gasket from rocker cover.

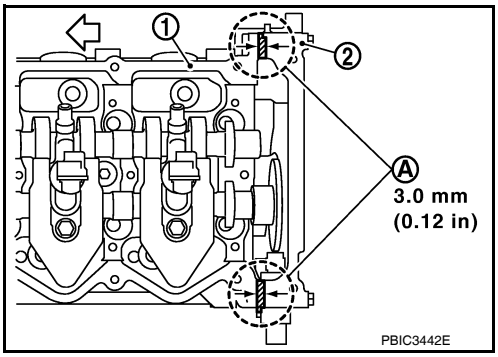
INSTALLATION

1. Install new gasket to rocker cover.
2. Apply liquid gasket with Tool on locations shown.

   Tool number : WS39930000

   • **Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".**

   1 : Cylinder head
   2 : Cylinder head rear cover
   A : Liquid gasket application area
   ⇦ : Front

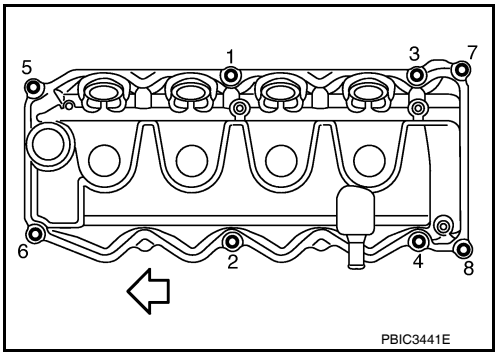


3. Tighten bolts in numerical order shown.

   ⇦ : Front

   : 7.8 N·m (0.8 kg-m, 69 in-lb)

   Re-tighten to the same specification in the same order as above.



4. Install nozzle oil seal.
   • Insert it straight until flange fully contacts rocker cover.
5. Installation of remaining parts is in the reverse order of removal.
6. Before starting engine, bleed air from fuel piping. Refer to EC-481, "Fuel Filter" (TYPE 1) or EC-726, "Fuel Filter" (TYPE 2).

INSPECTION AFTER INSTALLATION

Start engine and increase engine speed to check for fuel leak and engine oil leak.

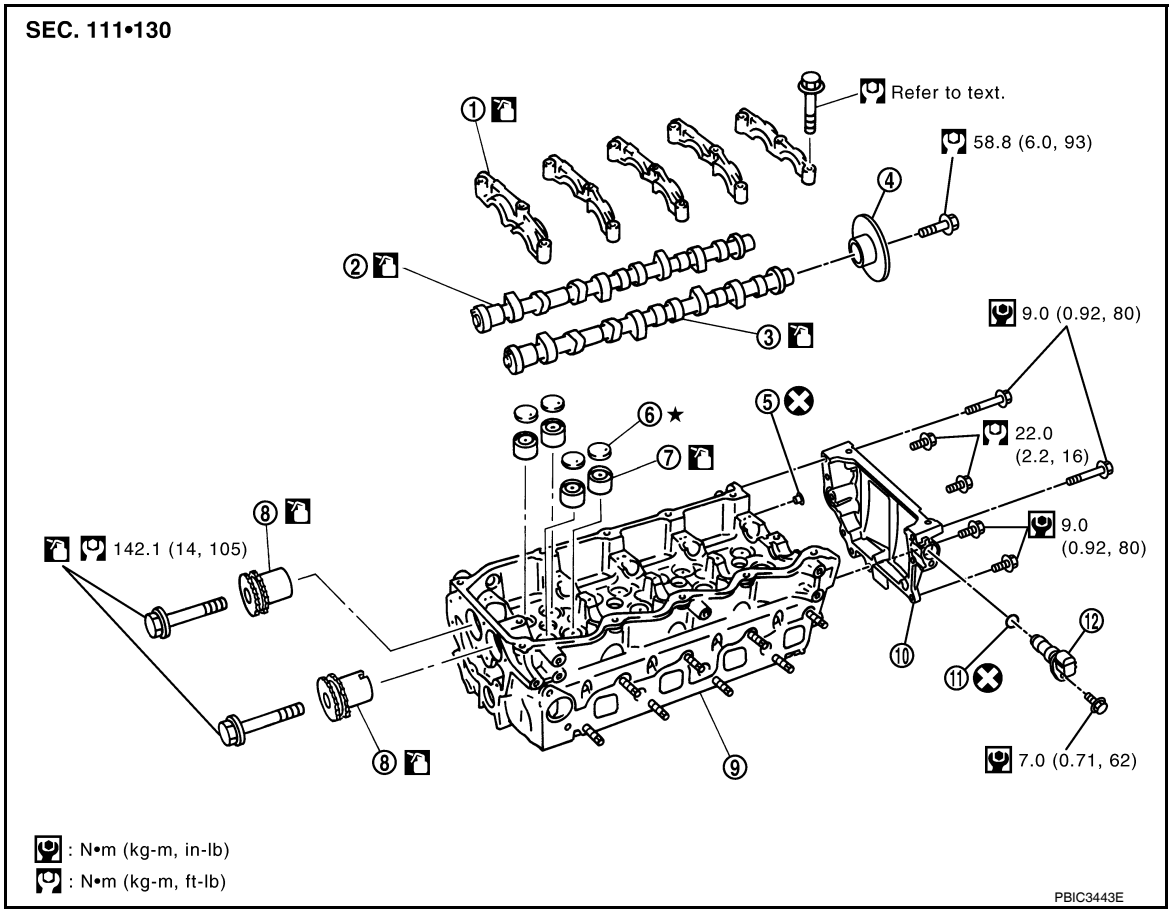
CAUTION:

Do not touch the engine immediately after stopped as engine becomes extremely hot.

CAMSHAFT

Component

INFOID:0000000006927528



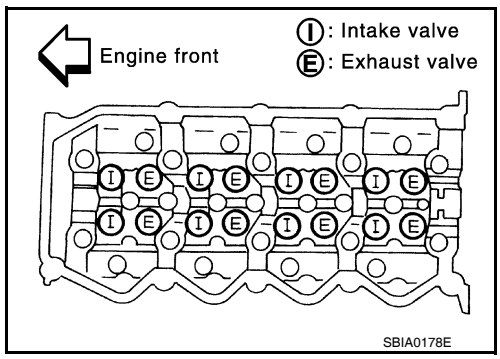
1. Camshaft bracket
2. Camshaft (right side)
3. Camshaft (left side)
4. Signal plate
5. Rubber washer
6. Adjusting shim
7. Valve lifter
8. Camshaft sprocket
9. Cylinder head
10. Cylinder head rear cover
11. O-ring
12. Camshaft position sensor

CAUTION:

- **This engine will have a different valve arrangement from normal DOHC 4-valve type engines. As both camshafts on this engine have intake and exhaust camshafts, in this chapter they are named as follows:**

  Camshaft (right side) : Intake manifold side
  Camshaft (left side) : Exhaust manifold side

- **The intake and exhaust valve arrangement is as shown. (The camshafts have, alternately, either intake valve or an exhaust valve.)**



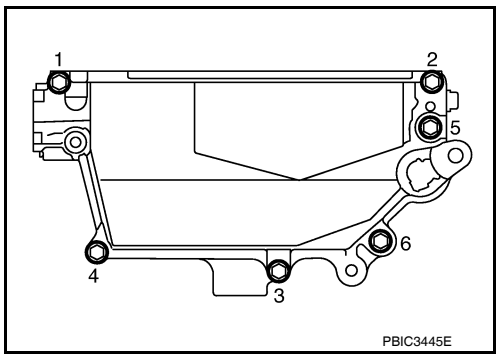
Removal and Installation

INFOID:0000000006927529

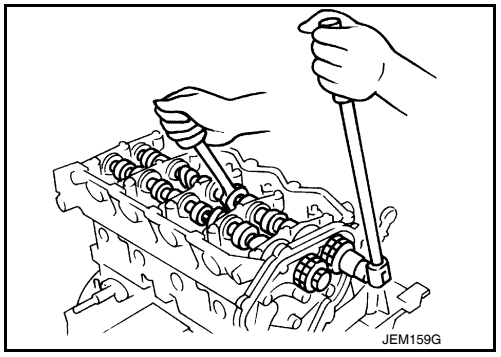
REMOVAL

1. Drain engine coolant. Refer to CO-33, "Changing Engine Coolant".
2. Remove rocker cover. Refer to EM-129, "Component".
3. Remove cylinder head rear cover, camshaft position sensor and rubber washer.

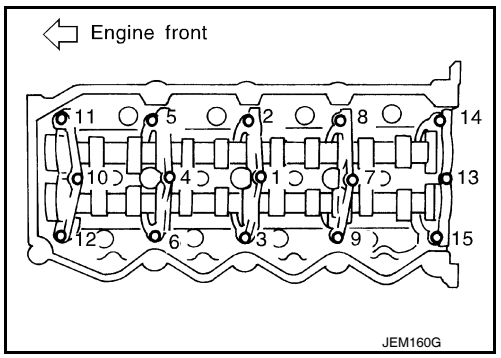
Loosen cylinder head rear cover bolts in the reverse order as shown.



4. Remove fuel injector. Refer to EM-117, "Component".
5. Remove secondary timing chain. Refer to EM-146, "Component".
6. Remove camshaft sprockets and signal plate.
   • Loosen the camshaft sprocket bolts and signal plate bolt by holding the hexagonal portion of camshaft with a suitable tool.



7. Remove camshaft.
   • Place distinguishing marks on the right and left sides with paint.
   • Loosen and remove the camshaft sprocket bolts in the reverse order as shown.



8. Remove adjusting shim and valve lifter.
   • Remove by taking notice of the installation position, and place outside engine in order to install them in the original position.

INSPECTION AFTER REMOVAL

Visual Check of Camshaft

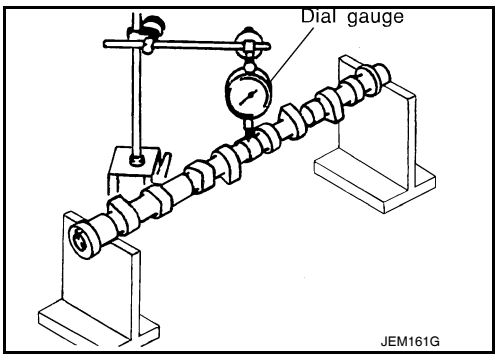
• Check the camshaft for one sided wear or scratches.
• Replace the camshaft if there are abnormalities.

Camshaft Runout

- Prepare V-block on a flat surface and secure camshaft journals No. 2 and No. 5.
- Set the dial gauge vertically on journal No. 3.
- Rotate camshaft in one direction by hand, then read needle movement on dial gauge. (Total indicator reading)

Limit : 0.02 mm (0.0008 in)

- If it exceeds the limit, replace camshaft.



Height of Cam Nose

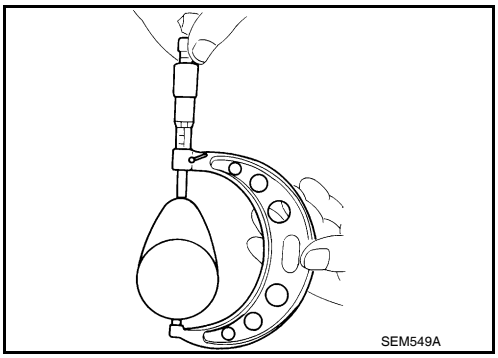
- Measure the height of cam nose using the micrometer.

Standard:

Intake : 39.505 - 39.695 mm (1.5553 - 1.5628 in)

Exhaust : 39.905 - 40.095 mm (1.5711 - 1.5785 in)

- If out of the standard, replace camshaft.



Camshaft Journal Oil Clearance

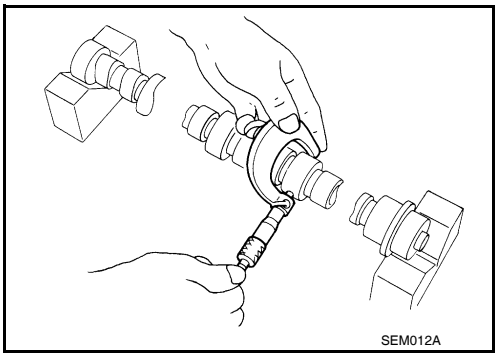
CAMSHAFT JOURNAL OUTER DIAMETER

- Measure outer diameter of camshaft journal with micrometer.

Standard:

No. 1 : 30.435 - 30.455 mm (1.1982 - 1.1990 in)

No. 2, 3, 4, 5 : 23.935 - 23.955 mm (0.9423 - 0.9431 in)



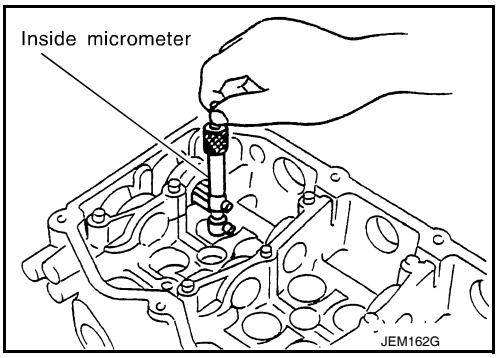
CAMSHAFT BRACKET INNER DIAMETER

- Install camshaft bracket and tighten bolts to the specified torque. Follow the INSTALLATION procedure for the tightening specification.
- Measure inner diameter of camshaft bracket using the inside micrometer.

Standard:

No. 1 : 30.500 - 30.521 mm (1.2008 - 1.2016 in)

No. 2, 3, 4, 5 : 24.000 - 24.021 mm (0.9449 - 0.9457 in)



CAMSHAFT OIL CLEARANCE CALCULATIONS

- (Oil clearance) = (Camshaft bracket inner diameter) – (Camshaft journal outer diameter)

Standard : 0.045 - 0.086 mm (0.0018 - 0.0034 in)

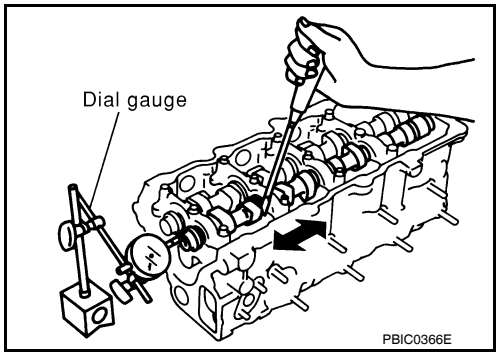
- If out of standard, replace the camshaft and/or cylinder head.

NOTE:
As the camshaft bracket is manufactured with the cylinder head, it is impossible to replace only the camshaft bracket.

Camshaft End Play

- Install dial gauge in thrust direction on front end of camshaft. Measure end play of dial gauge when camshaft is moved forward/backward (in direction to axis).

Standard : 0.070 - 0.148 mm (0.0028 - 0.0058 in)
Limit : 0.24 mm (0.0094 in)



- Measure the following parts if out of the standard.

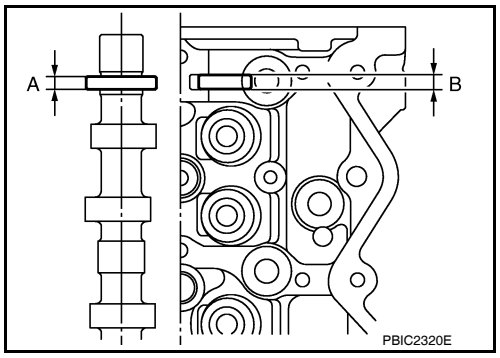
- Dimension “A” for camshaft

Standard : 6.882 - 6.930 mm (0.2709 - 0.2728 in)

- Dimension “B” for cylinder head

Standard : 7.000 - 7.030 mm (0.2755 - 0.2767 in)

- If out of standard, replace camshaft and/or cylinder head.

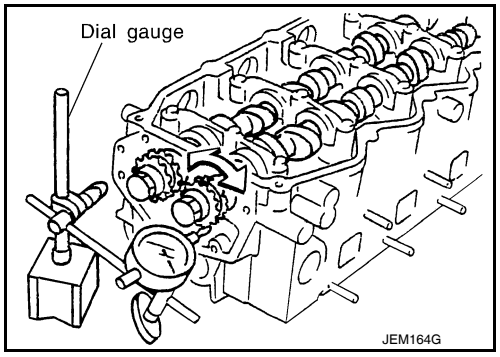


Camshaft Sprocket Runout

1. Install camshaft in cylinder head. Follow the INSTALLATION procedure for the tightening specification.
2. Install sprocket on camshaft. Follow the INSTALLATION procedure.
3. Measure camshaft sprocket runout. (Total indicator reading)

Limit : 0.15 mm (0.0059 in)

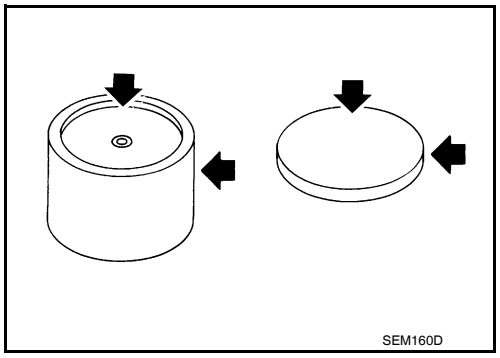
- If it exceeds the limit, replace camshaft sprocket.



Visual Inspection of Valve Lifter and Adjusting Shim

Check if surface of valve lifter and adjusting shim has any wear or cracks.

- If anything above is found, replace valve lifter or adjusting shim.

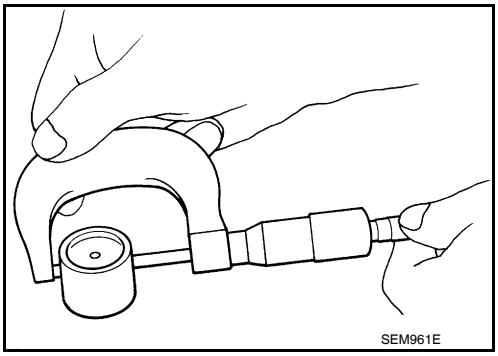


Valve Lifter Clearance

VALVE LIFTER OUTER DIAMETER

• Measure the outer diameter of the valve lifter with the micrometer.

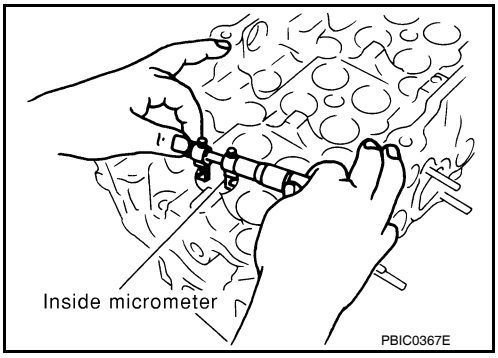
Standard : 29.960 - 29.975 mm (1.1795 - 1.1801 in)



VALVE LIFTER BORE DIAMETER

• Measure the bore diameter of the cylinder head valve lifter with the inside micrometer.

Standard : 30.000 - 30.021 mm (1.1811 - 1.1819 in)



VALVE LIFTER CLEARANCE CALCULATIONS

• (Clearance) = (Valve lifter bore diameter) – (Valve lifter outer diameter)

Standard : 0.025 - 0.061 mm (0.0010 - 0.0024 in)

• If out of standard, replace valve lifter and/or cylinder head.

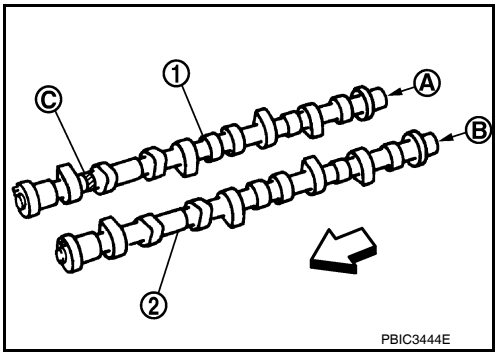
INSTALLATION

1. Install valve lifter and adjusting shim.
   • Make sure that these are installed in the same position as before the removal process.
2. Install camshaft.

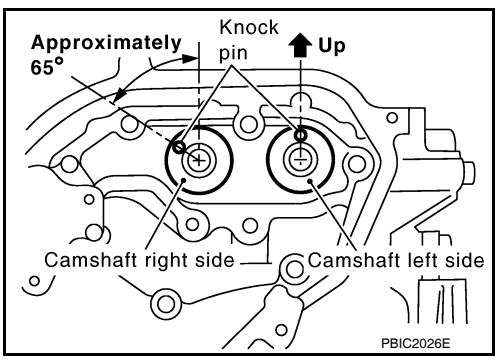
⇦ : Front

• Identify camshafts by the paint position and screw hole at the rear end.

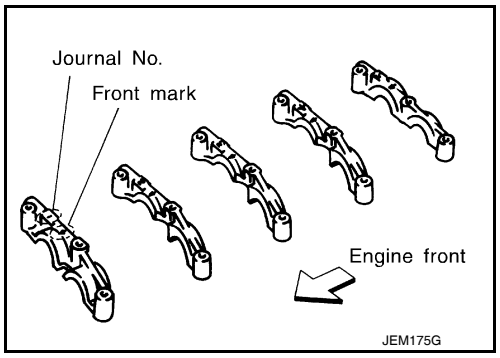
Camshaft (right side) Intake manifold side (1):
Paint is at position (C) (Blue) without screw hole (A).
Camshaft (left side) Exhaust manifold side (2):
No paint with screw hole (B).



• Install so that knock pins are positioned in the direction as shown.



3. Install camshaft brackets.
   - Completely remove any foreign material on back surfaces of camshaft brackets and top surface of cylinder head.
   - Install correctly, identifying brackets by the journal No. and front mark on top surface.



4. Tighten bolts in the order as shown according to the following procedure:

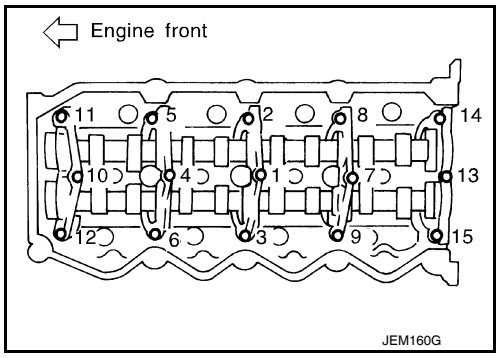
a. Tighten all bolts.

Bolt : 2 N·m (0.2 kg-m, 17 in-lb)

- Make sure camshaft thrusting parts (on rear side) securely fit in their mating parts on the cylinder head.

b. Tighten all bolts.

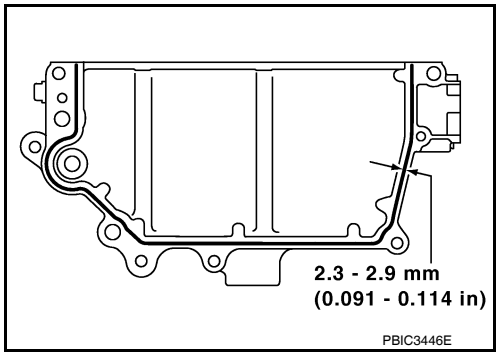
Bolt : 6 N·m (0.6 kg-m, 52 in-lb)



c. Tighten all bolts.

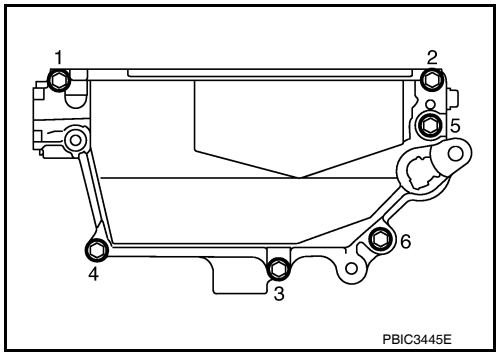
Bolt : 12 - 13 N·m (1.2 - 1.4 kg-m, 9 - 10 ft-lb)

5. Install camshaft sprockets and signal plate.
   - Camshaft sprockets are commonly used for right side and left side.
   - Align camshaft sprocket and knock pin on camshaft, and install.
   - Holding the hexagonal part of camshaft with a suitable tool, tighten bolt securing camshaft sprockets and signal plate.
6. Install rubber washer to cylinder head rear side.
7. Apply liquid gasket to cylinder head rear cover as shown.
   Use Genuine Liquid Gasket or Equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".



8. Install cylinder head rear cover and tighten bolts in numerical order as shown.

M6 × 50 mm : Bolt No.1, 2
M6 × 20 mm : Bolt No.3, 4
M8 × 20 mm : Bolt No.5, 6



9. Before installing spill tube after installing secondary timing chain, check and adjust valve clearance. Refer to EM-138, "Valve Clearance".
10. Installation of the remaining parts is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following are procedures checking for fluid leaks, lubrication leaks and exhaust gas leaks.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to LU-18, "Inspection" and CO-32, "System Inspection".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable components, such as cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level (*2)
Other oils and fluid (*1)	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

*1: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

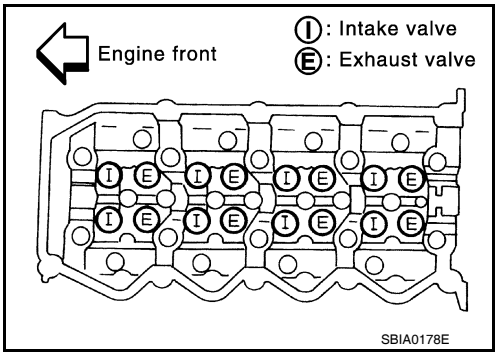
*2: Check engine oil level 10 minutes after engine stopped.

Valve Clearance

INFOID:0000000006927530

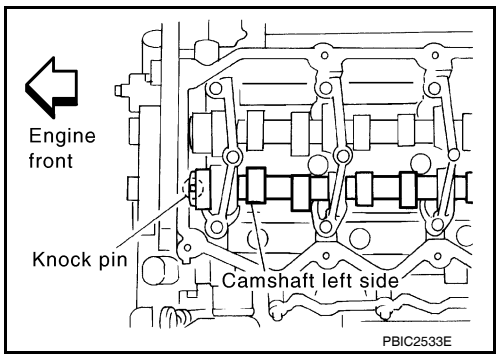
INSPECTION

- When the camshaft or parts in connection with valves are removed or replaced, and a malfunction has occurred (poor starting, idling, or other malfunction) due to the misadjustment of the valve clearance, inspect as follows.
- Inspect and adjust when the engine is cool (at normal temperature).
- Be careful of the intake and exhaust valve arrangement. The valve arrangement is different from that in a normal engine.
  NOTE:
  The camshafts have, alternately, either intake valve or exhaust valve as shown.



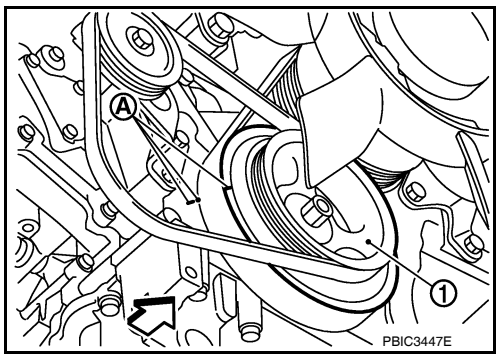
1. Remove rocker cover. Refer to EM-129, "Component".
2. Remove fuel injector. Refer to EM-117, "Component".
3. Set the No. 1 piston to TDC on its compression stroke.

- Turn crankshaft pulley clockwise so that the knock pin on camshaft left side faces straight above. (No position indicator, etc. is provided on the crankshaft pulley.)



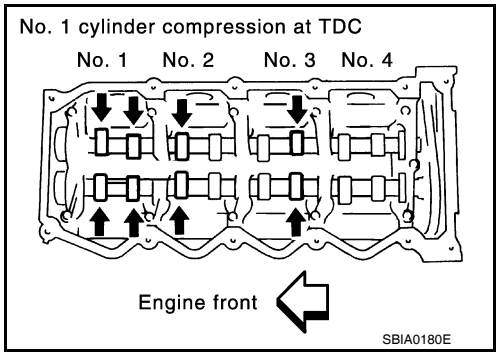
4. Remove engine undercover, put an alignment mark with paint, etc. on crankshaft pulley and on oil pump housing as an angle indicator.

1 : Crankshaft pulley
A : Alignment mark
⇦ : Vehicle front



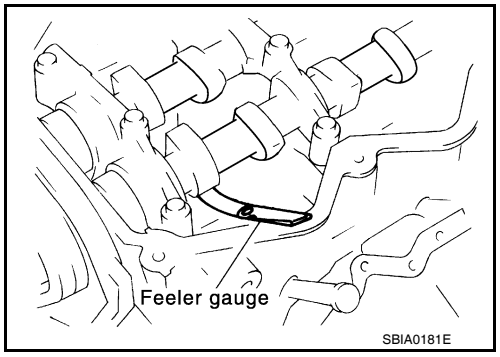
5. While referring to the illustration, measure the valve clearance marked in the table below.

Measuring point	No. 1		No. 2		No. 3		No. 4	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH
When the No. 1 cylinder is in the TDC	X	X	X			X		



NOTE:
- The injection order is 1-3-4-2.

- Measure the valve clearance using the feeler gauge when engine is cool (at normal temperature).



Valve clearance:

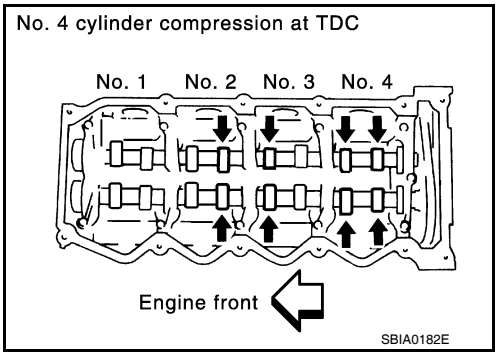
Unit: mm (in)

Item	Cold	Hot* (Reference data)
Intake	0.24 - 0.32 (0.0094 - 0.0126)	0.274 - 0.386 (0.0108 - 0.0152)
Exhaust	0.26 - 0.34 (0.0102 - 0.0134)	0.308 - 0.432 (0.0121 - 0.0170)

*: Reference data approximately 80°C (176°F)

6. Set the No. 4 cylinder at TDC by rotating the crankshaft clockwise once. (360 degrees)

7. While referring to the illustration, measure the valve clearance marked in the table below.



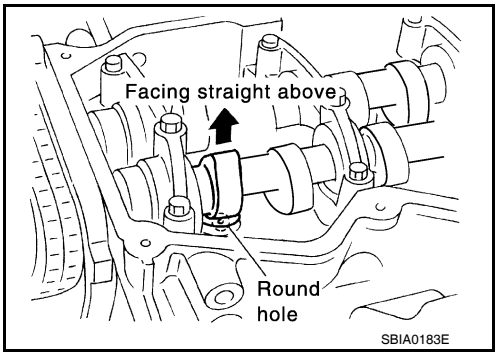
Measuring point	No. 1		No. 2		No. 3		No. 4	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH
When the No. 4 cylinder is in the TDC				X	X		X	X

8. If the valve clearance is outside the specification, adjust as follows.

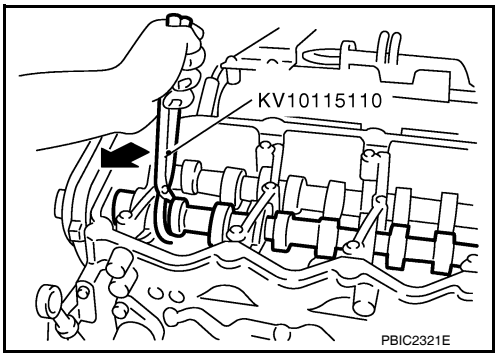
ADJUSTMENTS

- Remove adjusting shim for parts which are outside the specified valve clearance.

1. Remove engine oil on the upper side of the cylinder head (for the air blowing in step 6).
2. Rotate crankshaft to face the camshaft for adjusting shims that are to be removed upward.

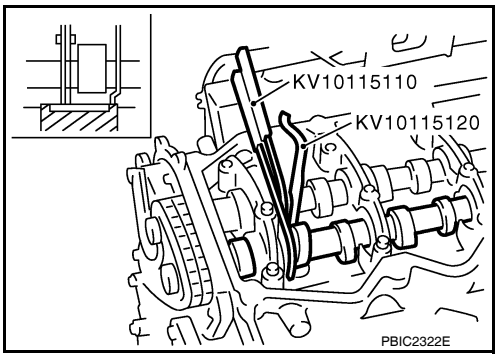


3. Grip camshaft with the Tool, then using camshaft as a support point, push adjusting shim downward to compress valve spring.
   CAUTION:
   Do not damage camshaft, cylinder head and the outer circumference of valve lifter.

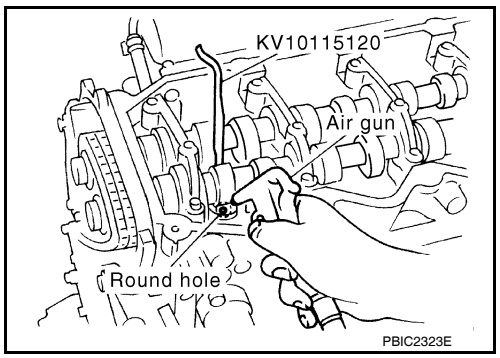


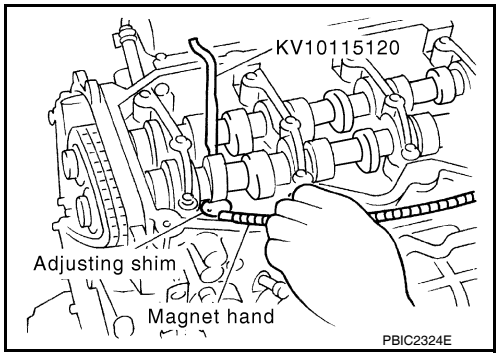
4. With valve spring in a compressed state, remove the Tool by securely setting the outer circumference of the valve lifter with the end of the Tool.
   - Hold the Tool by hand until the shim is removed.

   CAUTION:
   Do not remove the camshaft pliers forcefully, as camshaft will be damaged.

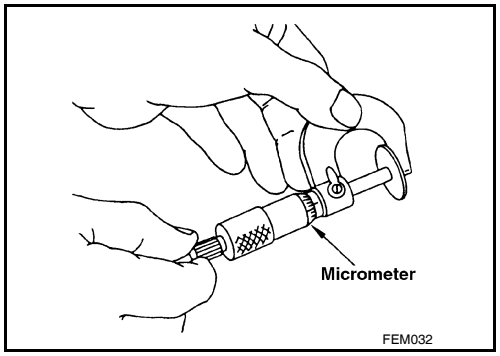


5. Move the round hole of adjusting shim to the front with a suitable tool.
   - When adjusting shim on valve lifter will not rotate smoothly, restart from step 3 to release the end of the Tool from touching adjusting shim.
6. Remove adjusting shim from valve lifter by blowing air through the round hole of the adjusting shim with the air gun.
   CAUTION:
   To prevent any remaining engine oil from being blown around, thoroughly wipe the area clean and wear protective goggles.
7. Remove adjusting shim by using the magnet hand.





8. Measure the thickness of adjusting shim using the micrometer.
   - Measure near the center of the shim (the part that touches camshaft).



9. Select the new adjusting shim from the following methods.

Calculation method of the adjusting shim thickness:

R = Thickness of removed shim

N = Thickness of new shim

M = Measured valve clearance

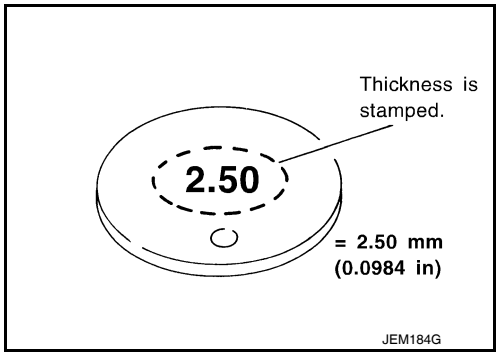
Intake

N = R + [M - 0.28 mm (0.0010 in)]

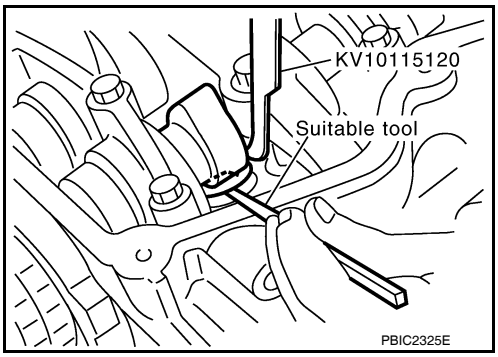
Exhaust

N = R + [M - 0.30 mm (0.0118 in)]

- New adjusting shims have the thickness stamped on the rear side.
- Shims are available in 33 size from 2.10 mm (0.0827 in) to 2.74 mm (0.1079 in), in steps of 0.02 mm (0.0008 in). Refer to EM-202, "Standard and Limit".



10. Fit the selected adjusting shim to valve lifter.
    CAUTION:
    Place the stamped side of adjusting shim to valve lifter.



11. Compress valve spring using the camshaft pliers and remove the lifter stopper.
12. Rotate crankshaft 2 to 3 turns by hand.
13. Confirm that the valve clearance is within the specification.
14. Installation of the remaining parts is in the reverse order of removal.
15. Warm up engine, and check for unusual noise and vibration.

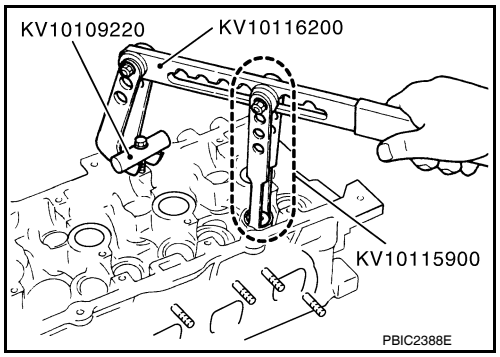
OIL SEAL

Removal and Installation of Valve Oil Seal

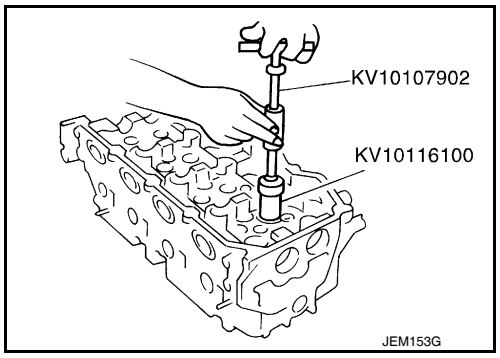
INFOID:0000000006927531

REMOVAL

1. Remove camshafts. Refer to EM-132, "Component".
2. Remove adjusting shims and valve lifters. Refer to EM-132, "Component".
   • Check the installation positions, and return them to the original position.
3. Rotate crankshaft, and set piston whose valve oil seal is to be removed to TDC. This will prevent valve from dropping into cylinder.
4. Remove valve collet.
   • Compress the valve spring with Tool. Remove valve collet with a magnet hand.
   CAUTION:
   When working, be careful not to damage valve lifter holes.

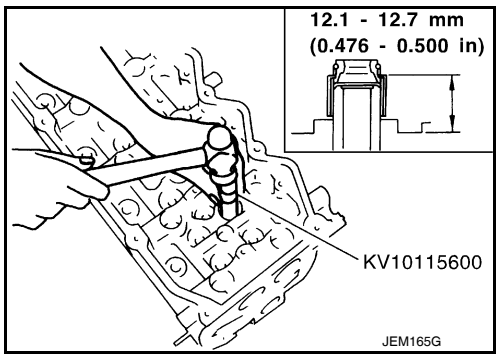


5. Remove valve spring retainer and valve spring.
6. Remove valve oil seal with the Tool.



INSTALLATION

1. Apply new engine oil to valve oil seal joint surface and seal lip.
2. Using the Tool to install valve oil seals to the dimension shown.



3. Installation of the remaining parts is in the reverse order of removal.

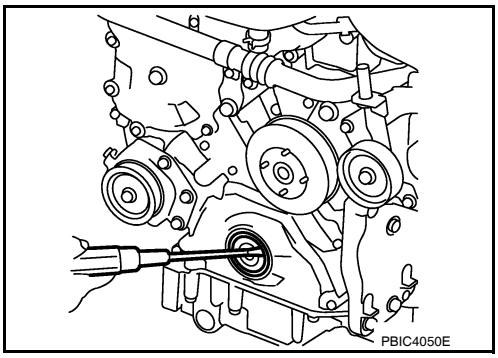
Removal and Installation of Front Oil Seal

INFOID:0000000006927532

REMOVAL

1. Remove the engine undercover.
2. Remove the drive belts. Refer to EM-88, "Checking Drive Belts".

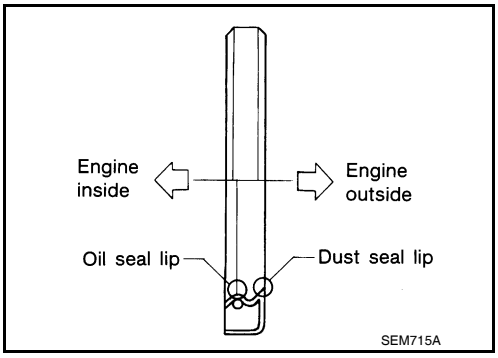
3. Remove the cooling fan. Refer to CO-38, "Removal and Installation".
4. Remove the crankshaft pulley. Refer to EM-152, "Component".
5. Remove front oil seal with a suitable tool.
   CAUTION:
   Be careful not to damage oil pump housing and crankshaft.



INSTALLATION

Installation is in the reverse order of removal.

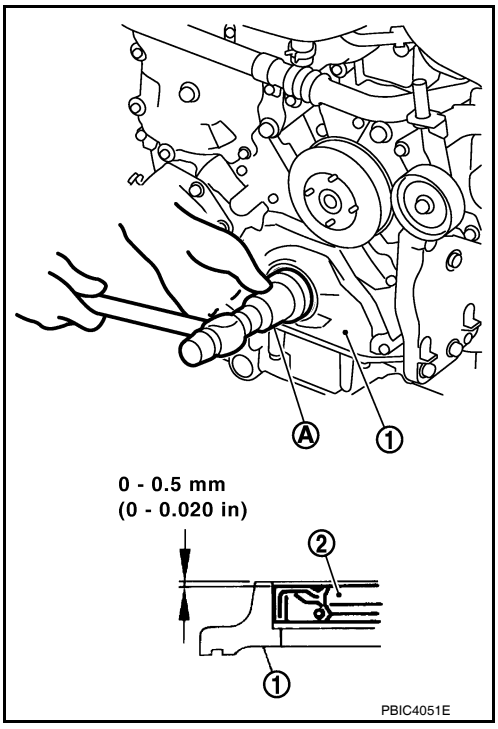
- Apply new engine oil to new front oil seal joint surface and seal lip.
- Install front oil seal so that each seal lip is oriented as shown.



- Using the suitable drift [60 mm (2.36 in) dia.] (A), press fit the oil seal (2) so that the dimension is as shown.

  1 : Oil pump

  CAUTION:
  Do not touch lips of oil seal. Make sure seal surfaces are free of foreign materials.



Removal and Installation of Rear Oil Seal

INFOID:0000000006927533

REMOVAL

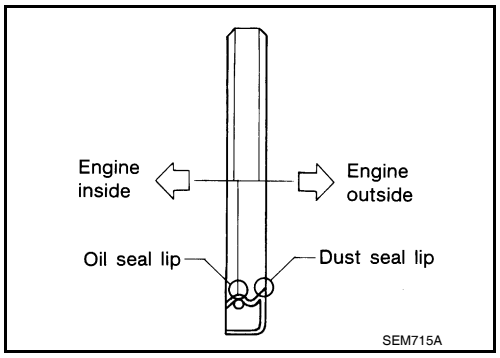
1. Remove transmission and transfer assembly, if equipped. Refer to MT-52, "Removal and Installation".

2. Remove flywheel. Refer to EM-179, "Component".
3. Remove rear oil seal with a suitable tool.
   CAUTION:
   Be careful not to damage crankshaft and cylinder block.

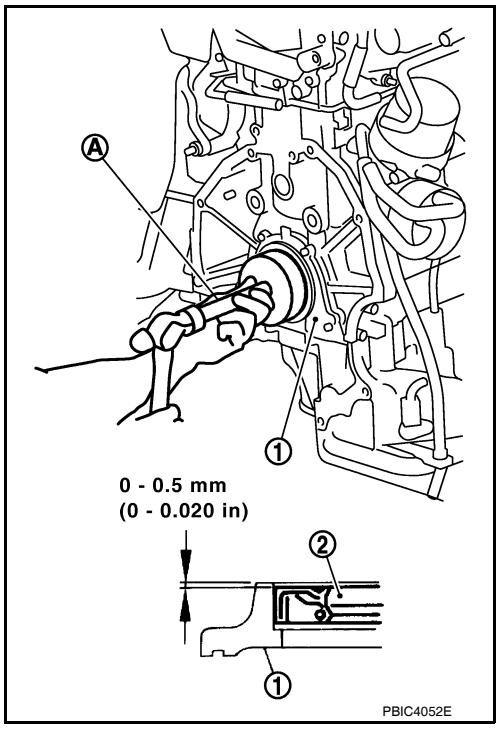
INSTALLATION

Installation is in the reverse order of removal.

- Apply new engine oil to new rear oil seal joint surface and seal lip.
- Install rear oil seal so that each seal lip is oriented as shown.



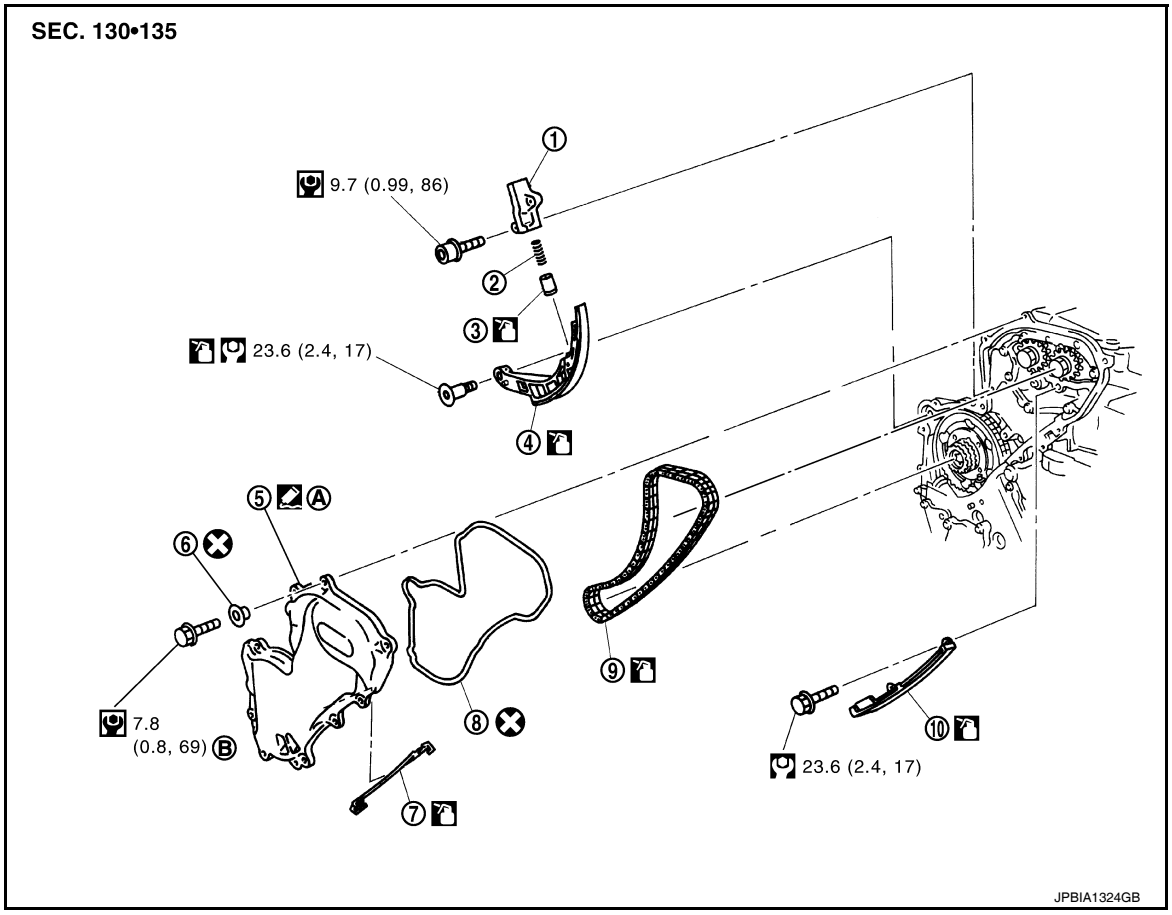
- Press in rear oil seal (2) to rear oil seal retainer (1) as shown.
- Using the drift [100 mm (3.94 in) dia.] (A), press fit so that the dimension is as shown.
- Avoid inclined fitting. Force fit perpendicularly.



SECONDARY TIMING CHAIN

Component

INFOID:0000000006927534



1. Chain tensioner	2. Spring	3. Plunger
4. Slack guide	5. Front chain case	6. Rubber washer
7. Tension guide	8. Gasket	9. Secondary timing chain
10. Tension guide	A. Oil pump side	B. Tighten twice

Removal and Installation

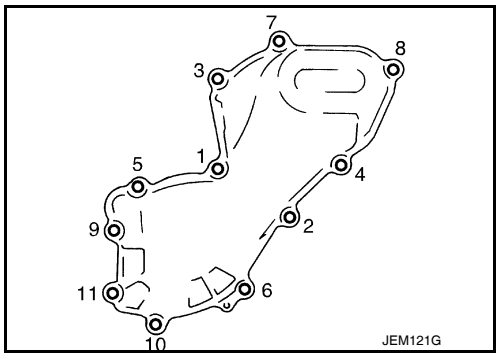
INFOID:0000000006927535

CAUTION:
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**

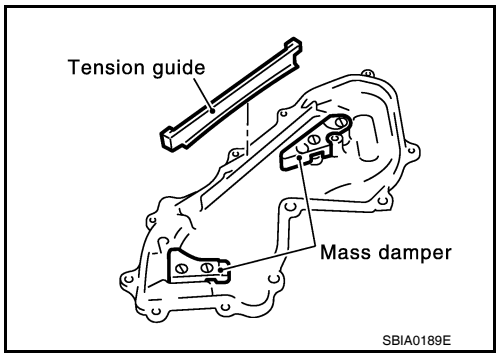
REMOVAL
- For preparative work for removing/installing secondary timing chain to remove/install fuel pump, refer to EM-122, "Component".
- To prepare for removing/installing secondary timing chain to remove/install camshaft, refer to EM-132, "Removal and Installation".

1. Remove radiator shroud (upper and lower). Refer to CO-35, "Component".
2. Remove cooling fan (crankshaft driven type). Refer to CO-38, "Removal and Installation".
3. Remove EGR cooler and related water hoses or EGR tube, if equipped. Refer to EM-93, "Component".
   CAUTION:
   - **Perform this step when engine is cold.**
   - **Do not spill engine coolant on drive belts.**

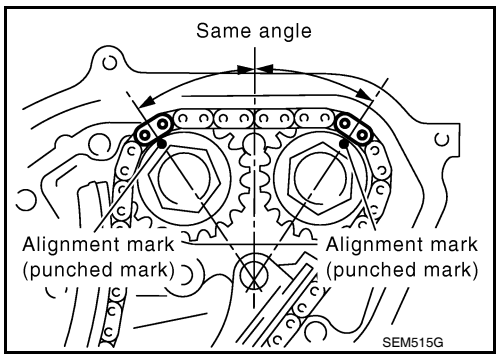
4. Remove front chain case.
   - Loosen bolts in reverse order of that shown and remove them.
     CAUTION:
     - **While front chain case is removed, cover openings to prevent entry of foreign material into engine.**



   - **Do not remove two mass dampers on the back of cover.**

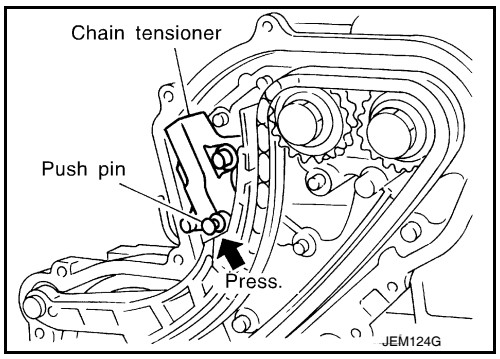


5. Set the No. 1 piston to TDC on its compression stroke.
   - Turn crankshaft pulley clockwise so that the alignment mark (punched mark) on each camshaft sprocket is positioned as shown.
   - **No position indicator is provided on crankshaft pulley.**
   - **When installing, color coded links on secondary timing chain can be used as alignment marks. Marking may not be necessary for removal; however, make alignment marks as required because the alignment mark on fuel pump sprocket may not be easy to see.**

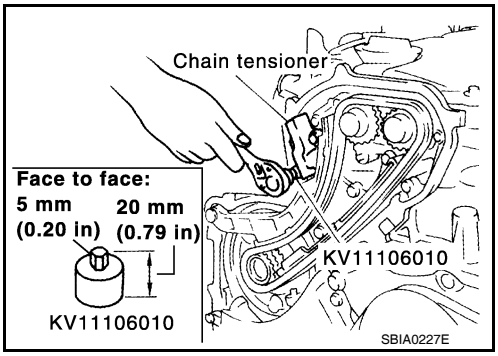


6. Remove chain tensioner.

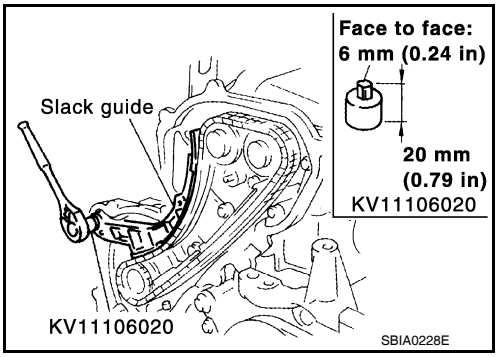
a. Push the plunger of chain tensioner and keep it pressed with a push pin.



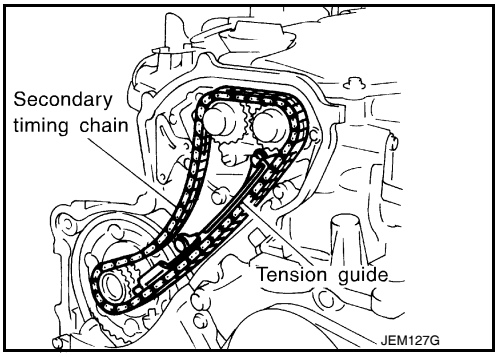
b. Use the Tool to remove bolts and remove chain tensioner.



7. Remove slack guide.
   • Use the Tool to remove bolt and remove slack guide.



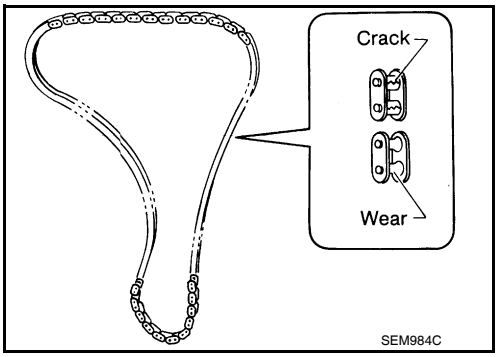
8. Remove tension guide.
9. Remove secondary timing chain.
   • Timing chain alone can be removed without removing sprockets.



INSPECTION AFTER REMOVAL

Timing Chain

Check for cracks and excessive wear at roller links. Replace timing chain if necessary.

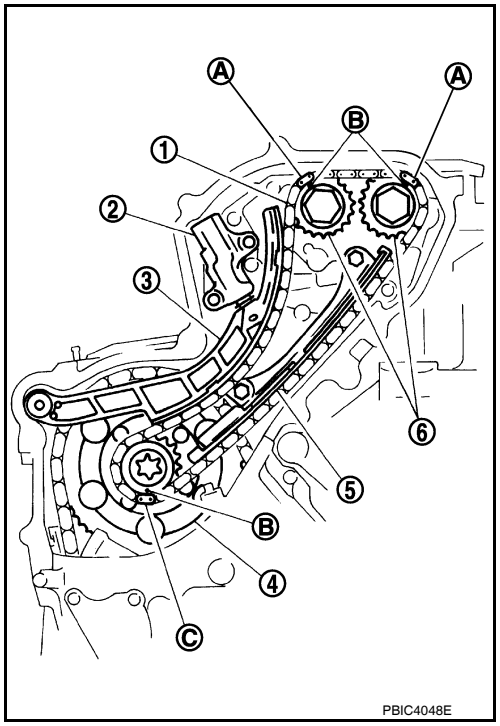


INSTALLATION

1. Install secondary timing chain.

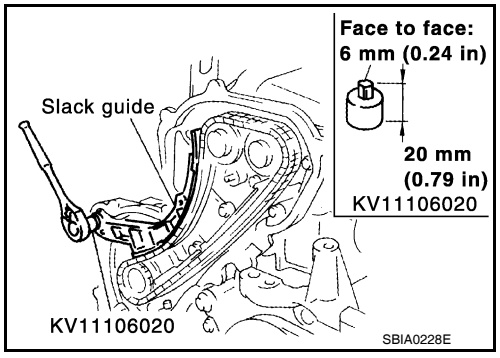
- Match the alignment marks on sprockets with color coded alignment marks (colored links) on the timing chain.

1 : Secondary timing chain
2 : Chain tensioner
3 : Slack guide
4 : Fuel pump sprocket
6 : Camshaft sprocket
A : Alignment mark (silver link)
B : Alignment mark (punched mark)
C : Alignment mark (yellow link)



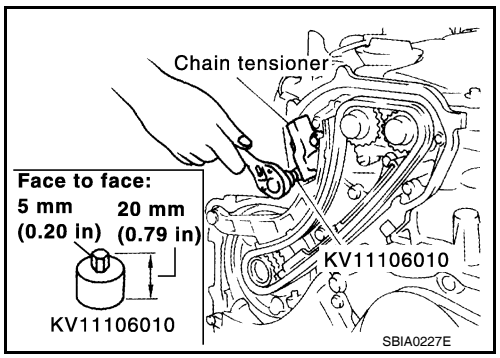
2. Install tension guide.
   - The upper bolt has a longer shank than the lower bolt.

3. Use the Tool to install slack guide bolts and slack guide.



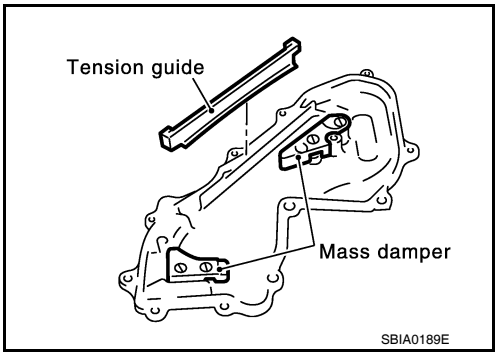
4. Install chain tensioner.

a. Push the plunger of chain tensioner. While holding it with a push pin, install chain tensioner.
b. Use the Tool to tighten bolts.
c. Pull out the push pin, etc. holding the plunger.
   - **Make sure again that the alignment marks on the sprockets and the colored alignment marks on the timing chain are aligned.**

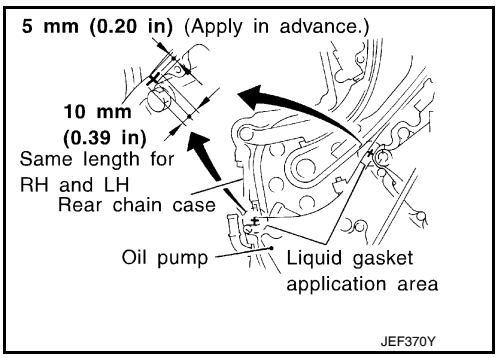


5. Install front chain case.

a. Install tension guide on the back surface of front chain case.
NOTE:
Hold front chain case vertically when installing. Tension guide may come off if front chain case is tilted.



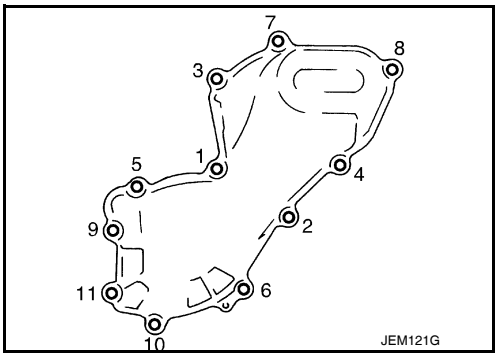
b. Apply a continuous bead of liquid gasket on both ends of arched area (locations where rear chain case is adjoined) as shown.
- **Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".**



c. Install front chain case.
- Align dowel pin on oil pump housing with the pin hole.
- Install No. 6, 10 and 11 bolts with the rubber washer to front chain case.

d. Tighten bolts in numerical order as shown.

e. After tightening all the bolts, re-tighten in the same order.



6. Installation of the remaining parts is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following procedures are checking for fluid leaks, lubrication leaks and exhaust gas leaks.
- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to LU-18, "Inspection", and CO-32, "System Inspection".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable components, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level (*2)
Other oils and fluid (*1)	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

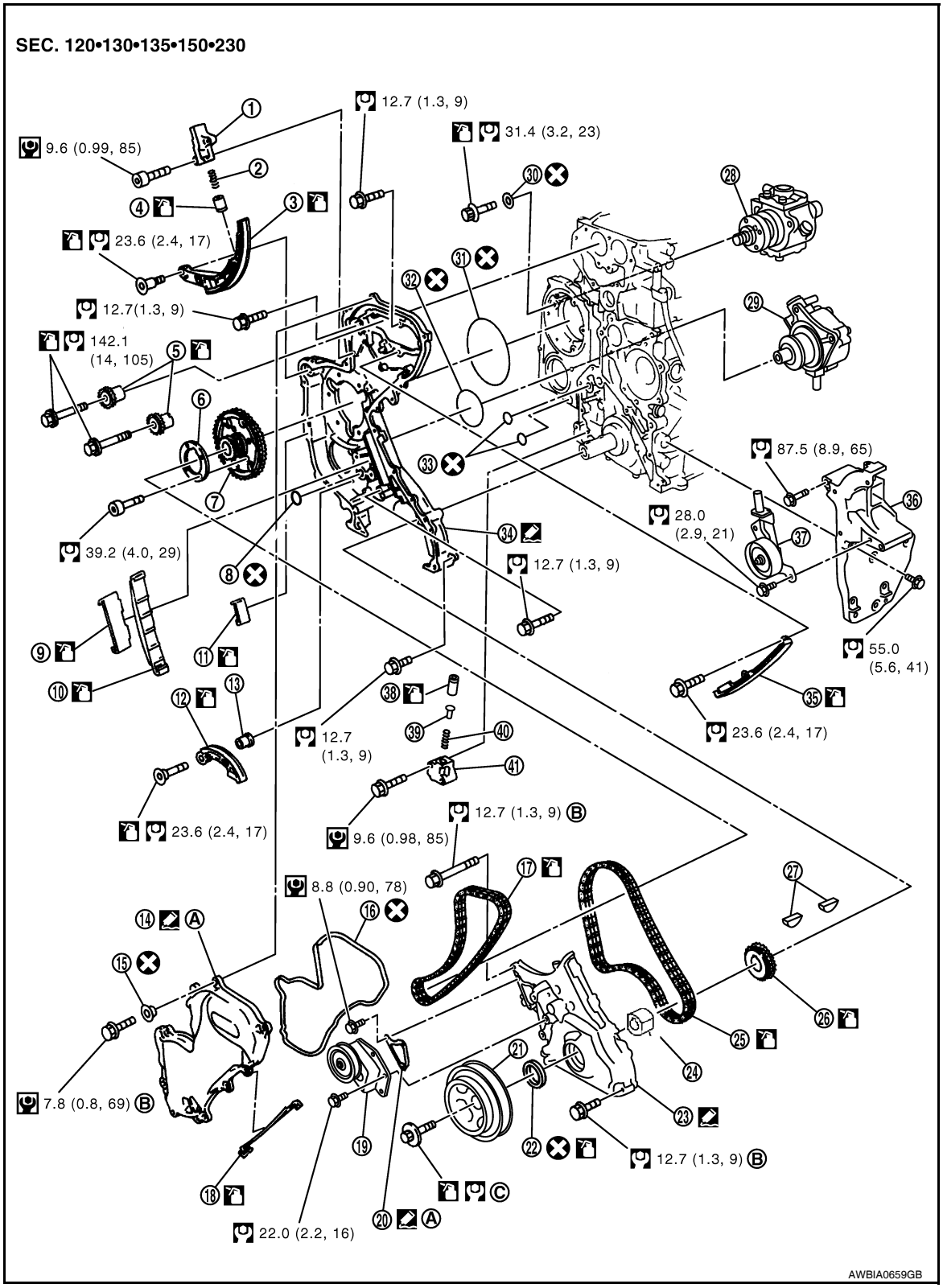
*1: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

*2: Check engine oil level 10 minutes after engine stopped.

PRIMARY TIMING CHAIN

Component

INFOID:0000000006927536



1. Chain tensioner
2. Spring
3. Slack guide
4. Plunger
5. Camshaft sprocket
6. Washer
7. Fuel pump sprocket
8. O-ring
9. Tension guide

10. Tension guide
11. Chain guide
12. Slack guide
13. Spacer
14. Front chain case
15. Rubber washer
16. Gasket
17. Secondary timing chain
18. Chain guide
19. Idler pulley
20. Vacuum pump cover
21. Crankshaft pulley
22. Front oil seal
23. Oil pump housing
24. Oil pump drive spacer
25. Primary timing chain
26. Crankshaft sprocket
27. Key
28. Fuel pump
29. Vacuum pump
30. Seal washer
31. O-ring
32. O-ring
33. O-ring
34. Rear chain case
35. Tension guide
36. A/C compressor bracket
37. Idler pulley
38. Plunger
39. Plug
40. Spring
41. Chain tensioner
A. Oil pump side
B. Tighten twice
C. Refer to EM-153

Removal and Installation

INFOID:0000000006927537

CAUTION:

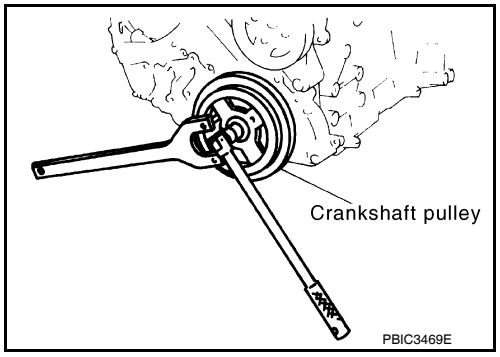
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surfaces with new engine oil.**

REMOVAL

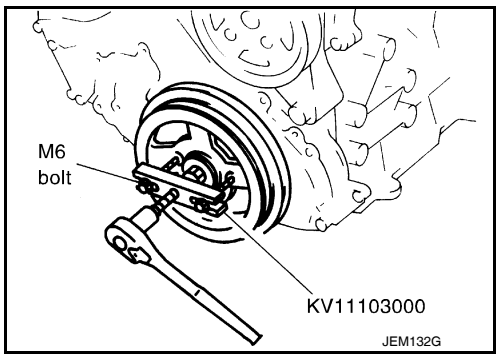
1. Remove power steering oil pump and power steering oil pump bracket. Refer to PS-13, "Description".
2. Remove idler pulleys. Refer to EM-88, "Checking Drive Belts".
3. Remove rocker cover. Refer to EM-129, "Component".
4. Remove oil pan (upper and lower). Refer to EM-108, "Component".
5. Remove fuel injector. Refer to EM-117, "Component".
6. Remove secondary timing chain and associated parts. Refer to EM-146, "Component".
7. When removing rear chain case, remove camshaft sprockets. Refer to EM-132, "Component".
8. Remove crankshaft pulley.

a. Hold crankshaft pulley with a suitable tool.

b. Loosen crankshaft pulley bolt and pull out the bolt approximately 10 mm (0.39 in).



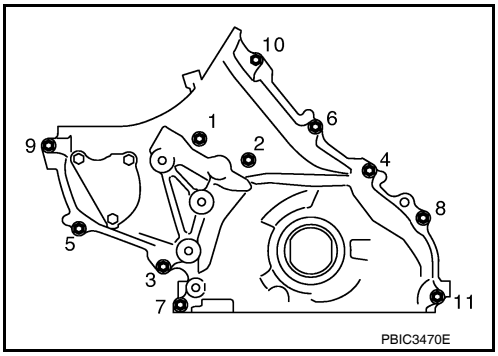
c. Use the Tool to remove crankshaft pulley.
   - Use two M6 bolts with approx. 60 mm (2.36 in) shank length for securing crankshaft pulley.



9. Remove oil pump housing.

- Loosen bolts in reverse order of that shown and remove them.
- Use the seal cutter for removal, if necessary.

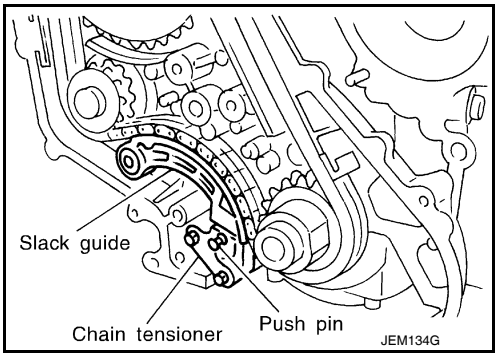
Tool number : KV10111100



10. Remove oil pump drive spacer.
11. Remove front oil seal from oil pump housing.
    - Punch out the seal off from the back surface of the oil pump housing using a suitable tool.

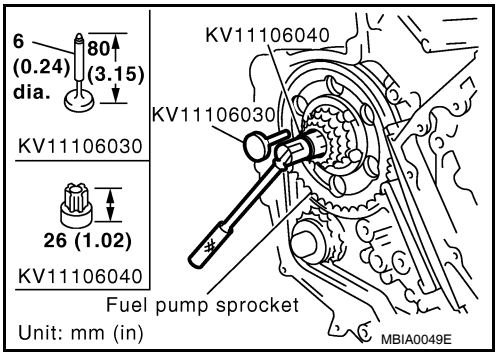
    CAUTION:
    Be careful not to damage oil pump housing.

12. Remove chain tensioner.
    - When removing chain tensioner, push the plunger of chain tensioner and keep it pressed with a push pin, etc.
13. Remove slack guide.

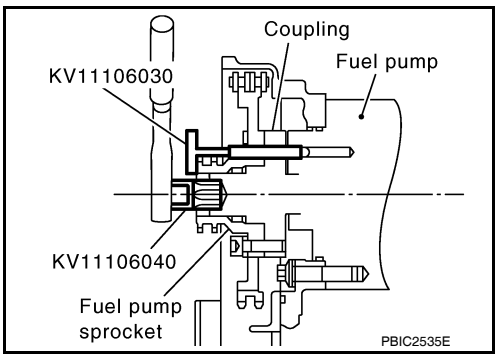


14. Hold fuel pump sprocket and remove bolt.

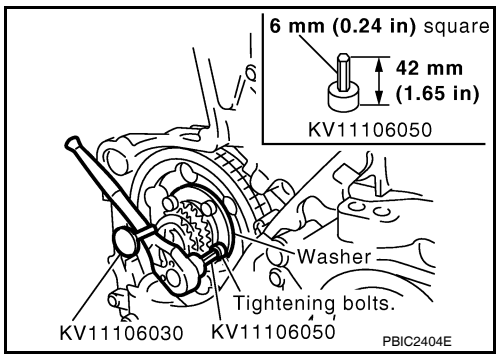
a. Insert Tool into the hole 6 mm (0.24 in) in the diameter on fuel pump sprocket.
b. Using the TORX wrench, turn pump shaft little by little to adjust the position of fuel pump sprocket so that the holes align.
c. Push Tool through fuel pump sprocket to fuel pump body to hold fuel pump sprocket.



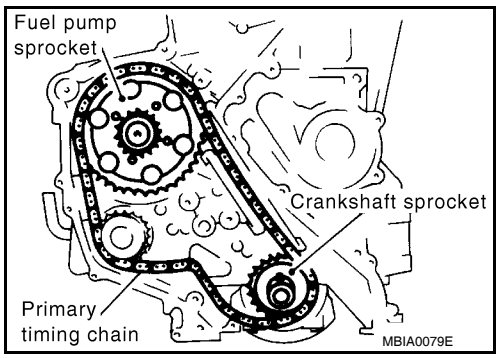
- Insert the Tool until its flange contacts fuel pump sprocket.



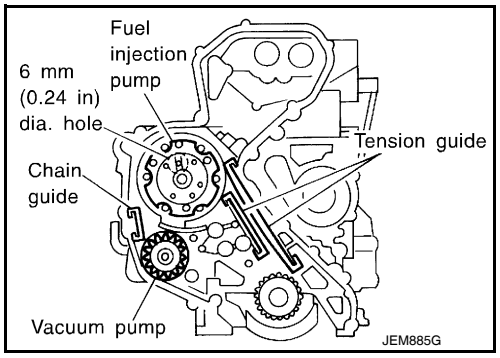
15. Use the Tool to remove fuel pump sprocket bolts.



16. Remove primary timing chain with fuel pump sprocket and crankshaft sprocket.



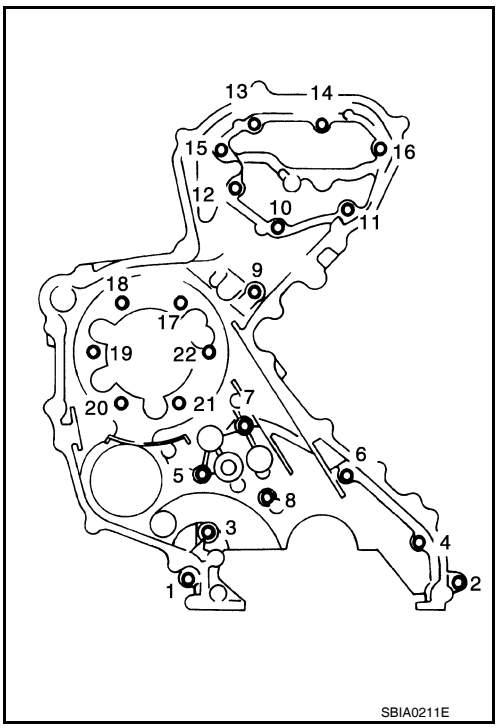
17. Remove chain guide and tension guides.



18. Remove fuel pump. Refer to EM-122, "Component".
19. Remove vacuum pump. Refer to EM-115, "Component".

20. Remove rear chain case.
    - Loosen bolts in the reverse order of that shown and remove them.
    - Use the seal cutter for removal, if necessary.

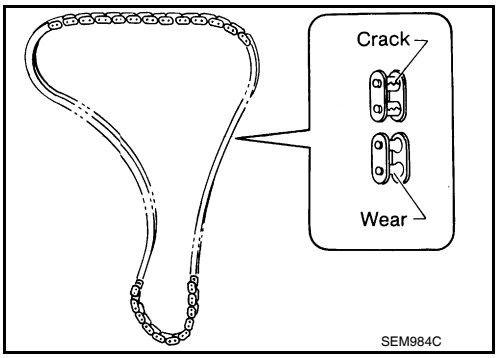
Tool number : KV10111100



INSPECTION AFTER REMOVAL

Timing Chain

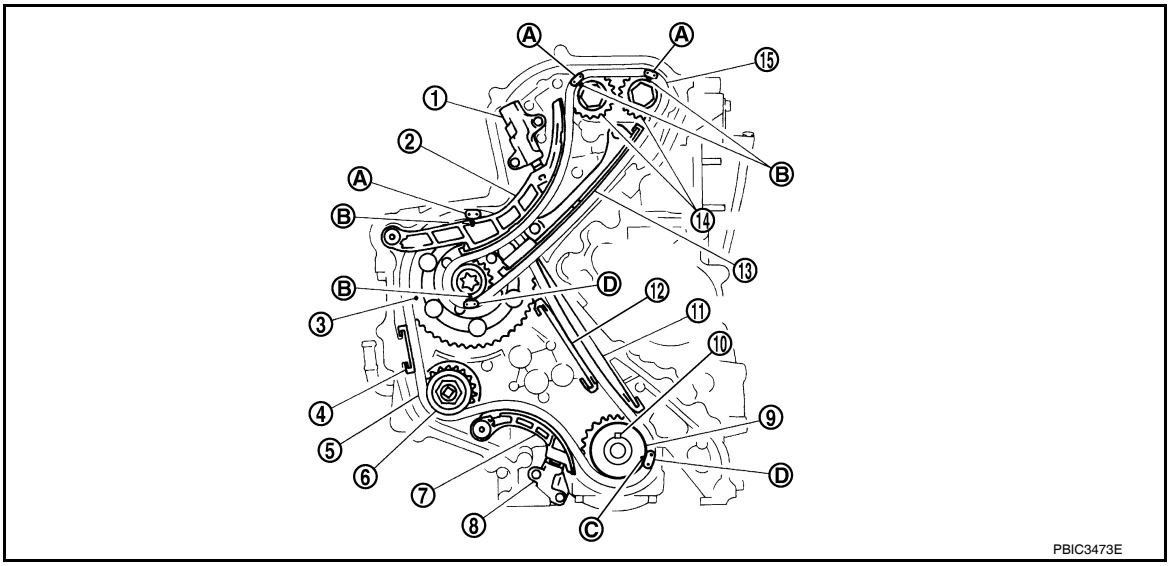
Check for cracks and excessive wear at roller links. Replace timing chain if necessary.



INSTALLATION

NOTE:

The illustration shows the relationship between the mating mark on each timing chain and that on the corresponding sprocket, with the components installed.



1. Chain tensioner
2. Slack guide
3. Fuel pump sprocket
4. Chain guide
5. Primary timing chain
6. Vacuum pump sprocket
7. Slack guide
8. Chain tensioner
9. Crankshaft sprocket
10. Key
11. Tension guide
12. Tension guide
13. Tension guide
14. Camshaft sprocket
15. Secondary timing chain

A. Alignment mark (silver link)
B. Alignment mark (punched mark)
C. Alignment mark (cut-out area)
D. Alignment mark (yellow link)

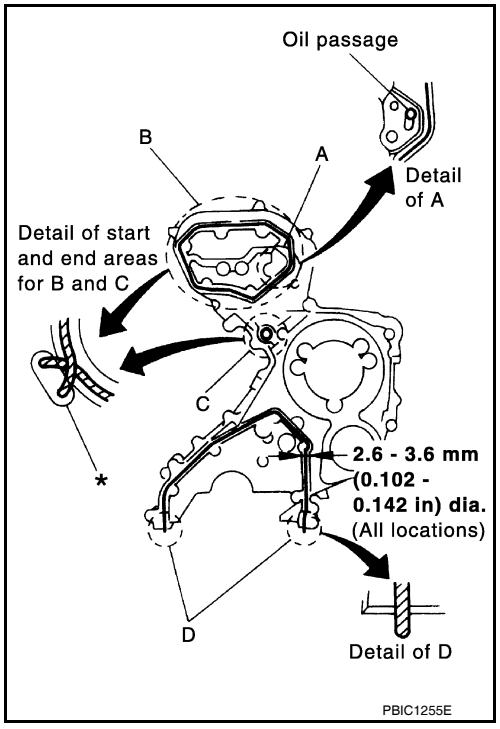
CAUTION:

Before starting work, make sure that No. 1 piston is on its compression stroke.

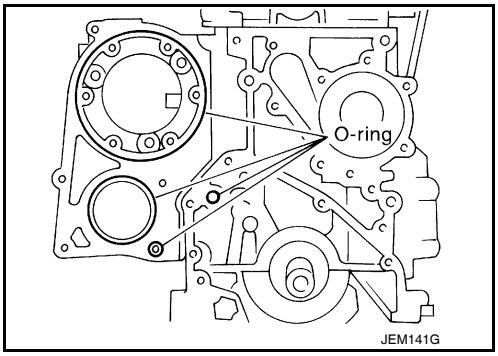
1. Install rear chain case.

a. Apply a continuous bead of liquid gasket with the Tool on locations shown.
Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".
A: Apply bead so that it does not protrude into the oil passage.
B, C: Minimize overlapping area of bead, by starting and ending at areas of bead as shown. Apply so that the portion marked * comes at an external location but cannot be viewed externally after engine assembly.
D: Leave the start and end areas of the bead slightly protruding from the case surface.

Tool number : WS39930000



b. Install four O-rings to the grooves of the cylinder block and fuel pump bracket as shown.



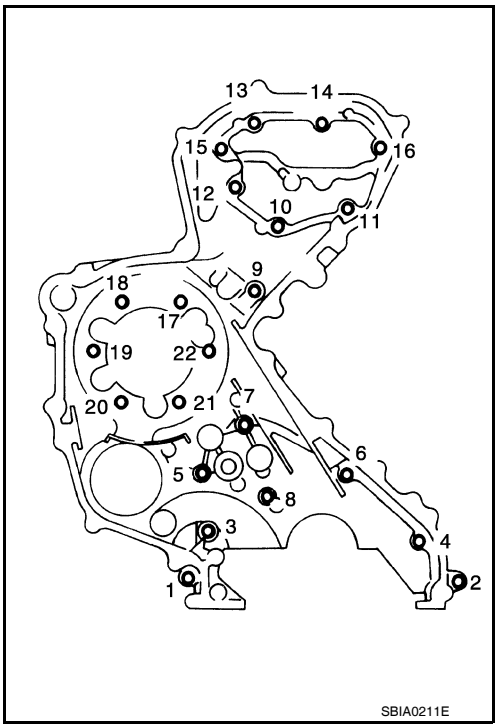
c. Install rear chain case.
   • Align the dowel pin with the pin hole.

d. Tighten bolts in numerical order as shown.
   • Install the following four types of bolts.

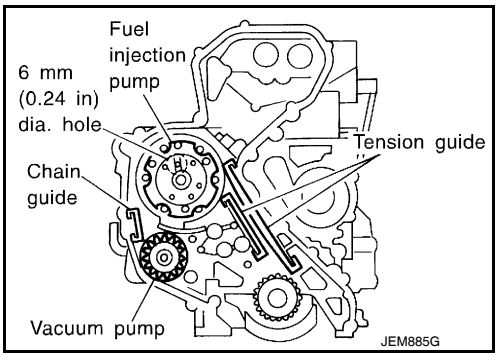
   16 mm (0.63 in) : Bolt No. 1, 2, 16, 17, 18, 19, 20, 21, 22
   20 mm (0.79 in) : Bolt No. 3, 4, 6, 9, 10, 11, 13, 14
   25 mm (0.98 in) : Bolt No. 12, 15
   35 mm (1.38 in) : Bolt No. 5, 7, 8

   • The shank length under the bolt neck above is the length of threaded part (pilot portion not included).

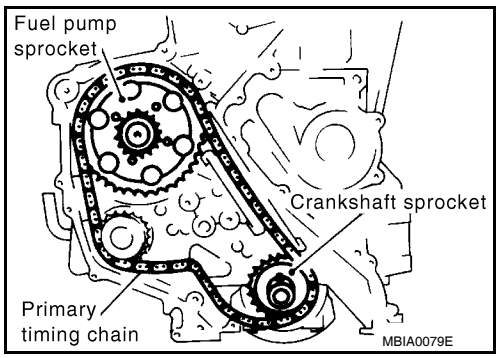
e. After tightening all the bolts, re-tighten in the same order.



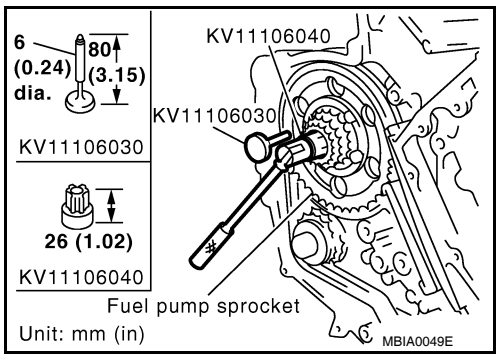
2. Install vacuum pump. Refer to EM-115, "Component".
3. Install fuel pump. Refer to EM-122, "Component".
   • Before installing, make sure that spacer and the hole 6 mm (0.24 in) in diameter on coupling are aligned.
4. Install chain guide and tension guides.
5. Install crankshaft sprocket, aligning it with crankshaft key on the far side.

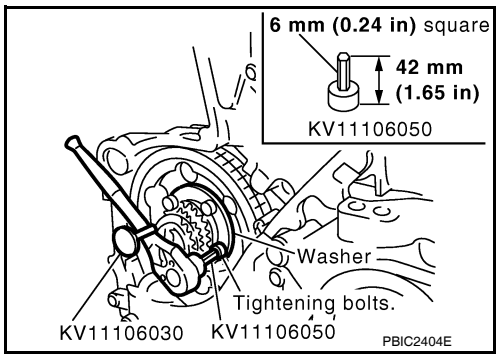


6. Install primary timing chain with fuel pump sprocket.
   - Match the alignment marks on sprockets with color coded alignment marks (colored links) on primary timing chain.
   - Install fuel pump sprocket washer with the surface marked “F” (front mark) facing the front of the engine.
7. Install timing chain onto power steering oil pump sprocket and through chain guide.



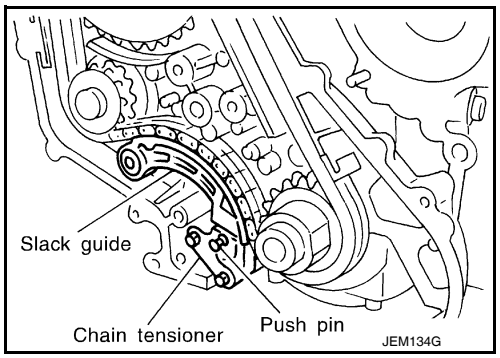
8. Use the Tool to hold the fuel pump sprocket and install the bolt.
   - Use the Tool to turn the fuel pump shaft little by little to adjust the position of the fuel pump sprocket. Insert Tool into the hole 6 mm (0.24 in) in diameter on fuel pump sprocket so that the stopper pin goes through the fuel pump body. While the stopper pin is in place, install the bolt.





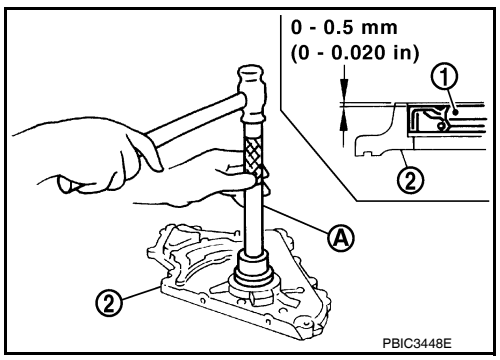
9. Install timing chain slack guide.
10. Install chain tensioner.
    - Push the plunger of the chain tensioner. While keeping plunger pressed down with a push pin, etc., install chain tensioner.
    - After installation, pull out the push pin holding the plunger.

CAUTION:
Make sure again that the alignment marks on sprockets and the colored alignment marks on timing chain are aligned.



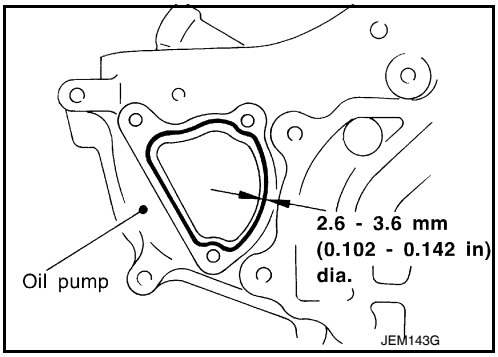
11. Install front oil seal (1) to oil pump housing (2).
    - Using the suitable drift (A) [62 mm (2.44 in) dia.], force fit the seal until it hits the bottom.

CAUTION:
Do not touch lips of oil seal. Make sure seal surfaces are free of foreign materials.

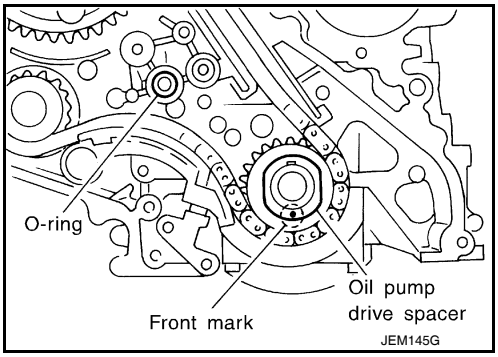


12. Install vacuum pump cover to oil pump housing.
    - Apply a continuous bead of liquid gasket with the Tool as shown.
      Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".
    - Apply liquid gasket on oil pump-side surface.

      Tool number : WS39930000



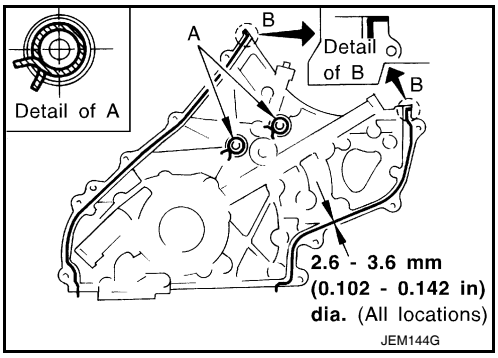
13. Install oil pump drive spacer.
    - Install oil pump drive spacer to crankshaft.
    - Install with the front mark (punched mark) facing the front of the engine as shown.
    - Install O-ring into the groove of rear chain case as shown.



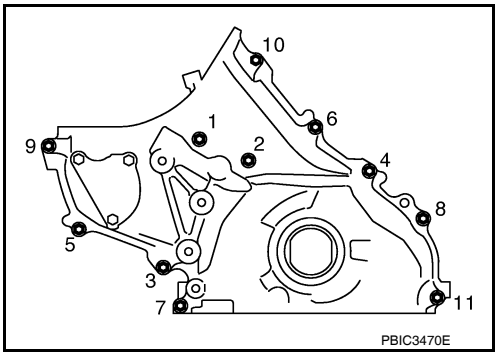
14. Install oil pump housing.

a. Apply a continuous bead of liquid gasket with the Tool as shown.
   Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".
   A: Leave the start and end areas of the bead slightly protruding from the surface.
   B: Apply liquid gasket along upper end surface of oil pump housing.

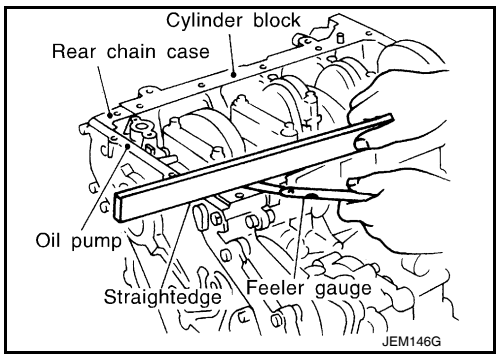
   Tool number : WS39930000



b. Install O-ring into the groove of rear chain case.
c. Install oil pump housing.
   - Align the inner rotor in the direction of the two facing flats of oil pump drive spacer.
   - Align the dowel pin with the pin hole.
d. Tighten bolts in numerical order as shown.
e. After tightening all the bolts, re-tighten in the same order.



15. Check gaps on upper oil pan mounting surface.
    - Using straightedge and feeler gauge, measure gaps between the locations of the following parts:



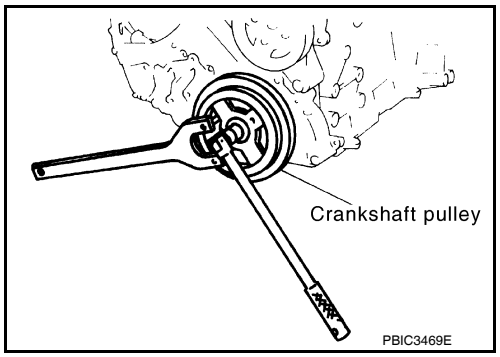
Oil pump housing and rear chain case:
Standard : – 0.09 to 0.09 mm (– 0.0035 to 0.0035 in)
Rear chain case and cylinder block:
Standard : – 0.19 to 0.07 mm (– 0.0075 to 0.0028 in)

- If the measured value is out of the standard, install again.

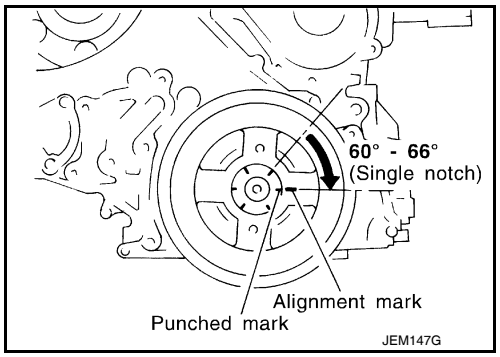
16. Install crankshaft pulley.
    CAUTION:
    Be careful not to damage front oil seal.

a. Install crankshaft pulley to crankshaft.
b. Apply new engine oil to thread and seat surfaces of crankshaft pulley bolt.
c. Hold crankshaft pulley with a suitable tool.
d. Tighten crankshaft pulley bolt to specification.

: 25.0 N·m (2.5 kg-m, 18 ft-lb)



e. Put an alignment mark on crankshaft pulley that aligns with one of the punched marks on the bolt as shown.
f. Tighten bolt another 60 - 66 degrees (angle tightening) [target: 60 degrees (turn by 1 notch)].



17. Install secondary timing chain and the associated parts. Refer to EM-146, "Removal and Installation".
18. Installation of the remaining parts is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following procedures are for checking fluid leaks, lubrication leaks and exhaust gas leaks.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to LU-18, "Inspection" and CO-32, "System Inspection".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable components, such as in cooling system.

- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level (*2)
Other oils and fluid (*1)	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

*1: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

*2: Check engine oil level 10 minutes after engine stopped.

CYLINDER HEAD

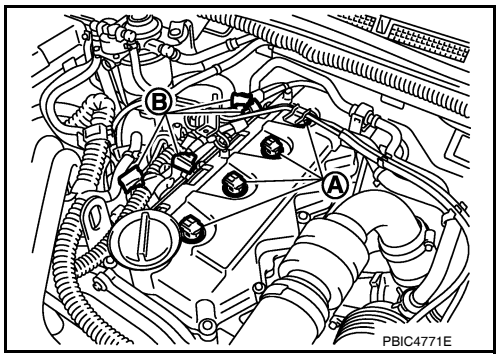
On-Vehicle Service

INFOID:0000000006927538

CHECKING COMPRESSION PRESSURE

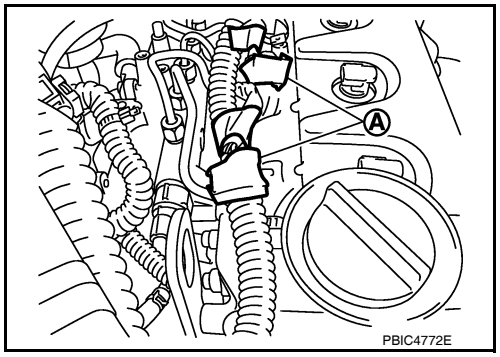
1. Warm up engine thoroughly. Then, stop it.
2. Use CONSULT-III to make sure no error codes are indicated for self-diagnosis items. Refer to EC-493, "Basic Inspection".
   - Do not disconnect CONSULT-III until the end of this operation; it will be used to check engine rpm and for error detection at the end of this operation.
3. Disconnect the battery cable from the negative terminal. Refer to SC-6, "Removal and Installation".
4. Remove charge air cooler. Refer to EM-92, "Removal and Installation".
5. To prevent fuel from being injected during inspection, disconnect all the connectors of the fuel injector.

   A : Injector
   B : Connector



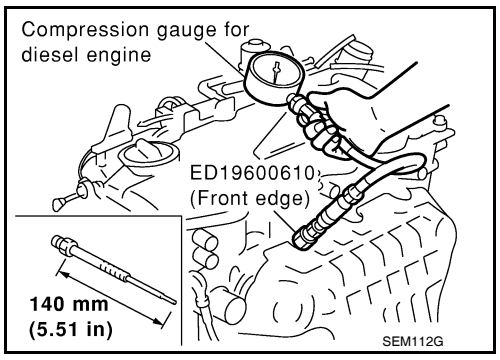
6. Wind the insulating tape around the electrode of the disconnected connectors. Tie them together and secure them on the harness side.

   A :Connector



7. Remove glow plugs from all the cylinders. Refer to EM-114, "Component".
   CAUTION:
   - **Before removal, clean the surrounding area to prevent entry of any foreign materials into engine.**
   - **Carefully remove glow plugs to prevent any damage or breakage.**
   - **Handle with care to avoid applying any shock to glow plugs.**
8. Install Tool to installation holes of glow plugs and connect compression gauge for diesel engine.

   : 20.0 N·m (2.0 kg-m, 15 ft-lb)



9. Connect the battery cable to the negative terminal. Refer to SC-6, "Removal and Installation".
10. Turn ignition switch to “START” for cranking. When the gauge pointer stabilizes, read the compression pressure and engine rpm. Perform these steps to check each cylinder.
    - Always use a fully-charged battery to obtain specified engine speed.

    Compression pressure

Unit: kPa (bar, kg/cm^2, psi)/rpm

Standard	Minimum	Difference limit between cylinders
3,100 (31, 31.6, 450)/200	2,500 (25, 25.5, 363)/200	490 (4.9, 5.0, 71)/200

- When engine rpm is out of the specified range, check the specific gravity of battery liquid. Measure again under corrected conditions.
- If engine rpm exceeds the limit, check valve clearance and combustion chamber components (valves, valve seats, cylinder head gaskets, piston rings, pistons, cylinder bores, cylinder block upper and lower surfaces) and measure again.
- If compression pressure is low in some cylinders, apply engine oil from glow plug installation hole. Then check pressure again.
  - If compression pressure becomes normal after applying engine oil, piston ring may be worn or damaged. Check piston ring for malfunction. If any, replace piston ring.
  - If compression pressure is still low after applying engine oil, valve may be malfunctioning. Check valve for malfunction. If contact malfunction is found, replace valve or valve seat.
- If compression pressure in adjacent two cylinders is low after applying engine oil, pressure may be leaking from gasket. In this case, replace cylinder head gasket.

11. Complete this operation as follows:

a. Turn the ignition switch to “OFF”.

b. Disconnect the battery cable from the negative terminal. Refer to SC-6, "Removal and Installation".

c. Install glow plug and install all the parts removed in step 4.

d. Connect all the connectors of the fuel injector.

e. Connect the battery cable to the negative terminal. Refer to SC-6, "Removal and Installation".

f. Check DTC. If DTC is displayed, erase it. Refer to EC-484, "Diagnostic Trouble Code (DTC)"

Component

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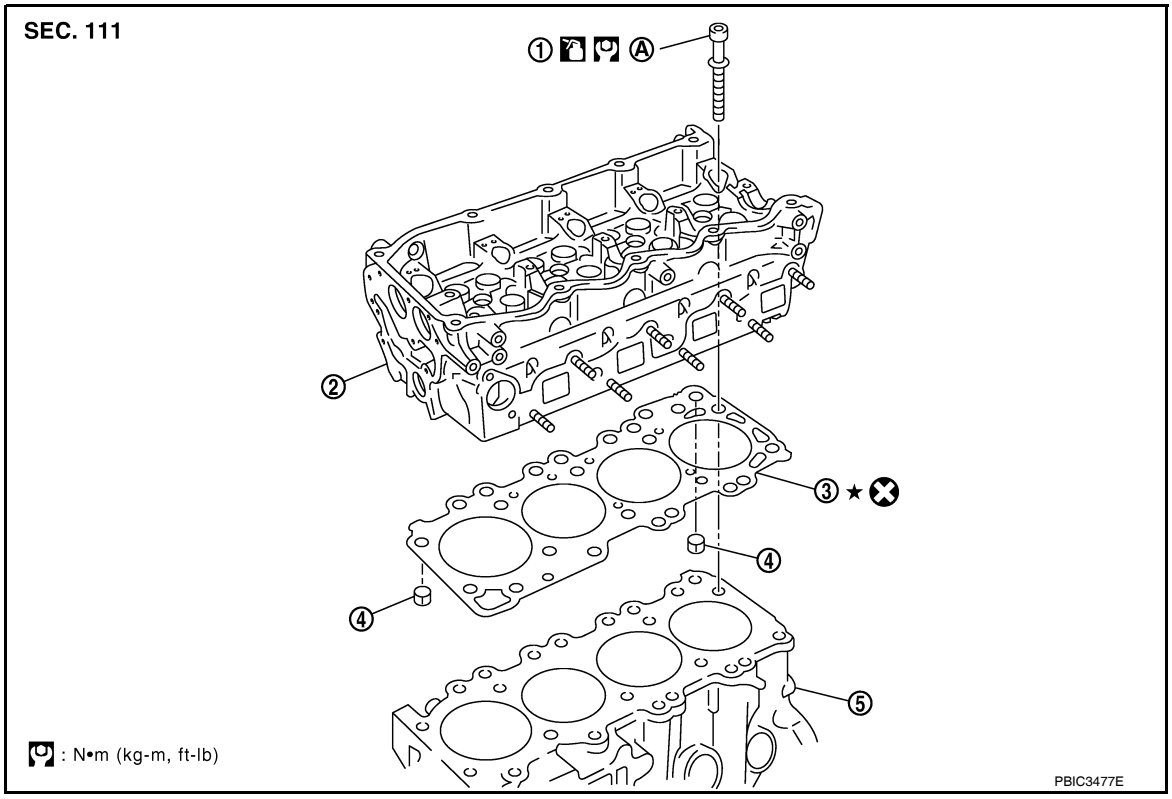

1. Cylinder head bolt
2. Cylinder head assembly
3. Gasket
4. Dowel pin
5. Cylinder block

A. Refer to EM-165.

Removal and Installation

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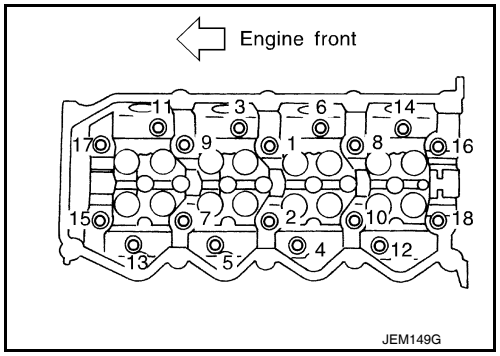
REMOVAL

1. Drain engine coolant. Refer to CO-33, "Changing Engine Coolant".
2. Remove the following:
   - Rocker cover (Refer to EM-129, "Component".)
   - Spill tube and fuel injector (Refer to EM-117, "Component".)
   - Intake manifold (Refer to EM-93, "Component".)
   - Turbocharger (Refer to EM-100, "Component".)
   - Exhaust manifold (Refer to EM-105, "Component".)
   - Secondary timing chain (Refer to EM-146, "Component".)
   - Camshaft (Refer to EM-132, "Component".)
3. Remove cylinder head assembly.
   - Remove bolts between rear chain case and cylinder head. Refer to EM-152, "Component".
   - Remove cylinder head bolts in the reverse order as shown with the suitable tool.
   - Lift up cylinder head assembly to avoid interference with dowel pins located between the cylinder block and cylinder head, and remove cylinder head assembly.

     CAUTION:

     Remove glow plug in advance to avoid damage as the tip of the glow plug projects from the bottom of cylinder head, or, place wood blocks beneath both ends of cylinder head to keep the cylinder bottom from any contact.



   - For glow plug removal, the following shall be noted.

     CAUTION:

     - **To avoid breakage, do not remove glow plug unless necessary.**
     - **Perform continuity test with glow plug installed.**
     - **Keep glow plug from any impact. [Replace if dropped from a height 10 cm (3.94 in) or higher.]**
     - **Do not use air impact wrench.**

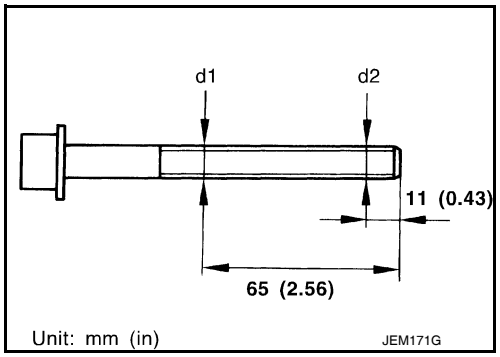
INSPECTION AFTER REMOVAL

Cylinder Head Bolt Deformation

- Using micrometer, measure the outer diameters d1 and d2 of bolt thread as shown.
- If the necking point can be identified, set it as measuring point d1.
- Calculate the difference between d1 and d2.

Limit : 0.15 mm (0.0059 in)

- If it exceeds the limit, replace cylinder head bolt.



Cylinder Head Distortion

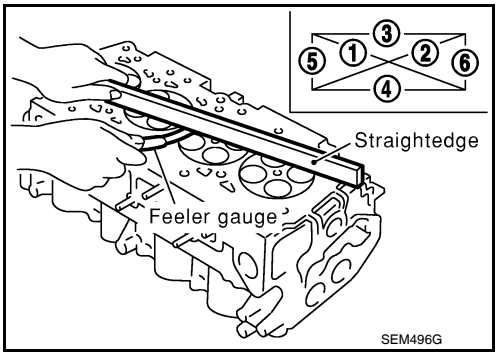
1. Wipe off oil and remove water scale (like deposit), gasket, sealer, carbon, etc. with scraper.

   CAUTION:

   Use utmost care not to allow gasket debris to enter passages for oil or water.

2. At each of several locations on bottom surface of cylinder head, measure distortion in six directions.

Limit : 0.1mm (0.004 in)

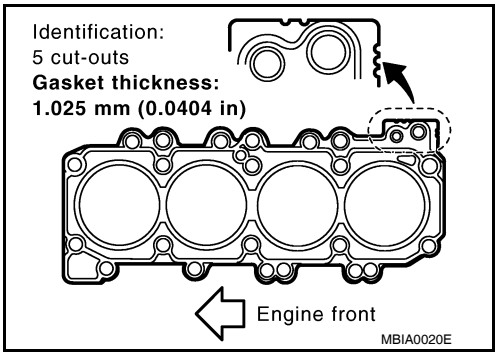


- If it exceeds the limit, replace cylinder head.

INSTALLATION

Before installation, remove old liquid gasket from mating surface of all liquid gasket applied parts.

1. Install cylinder head gasket.
   - Cylinder head gasket to be installed is selected by its thickness through the following procedure.
   - **When replacing gasket alone**
   - Install a gasket with same thickness as that of the one removed.
   - Identify the thickness of gasket by the number of cut-outs on the rear RH side.

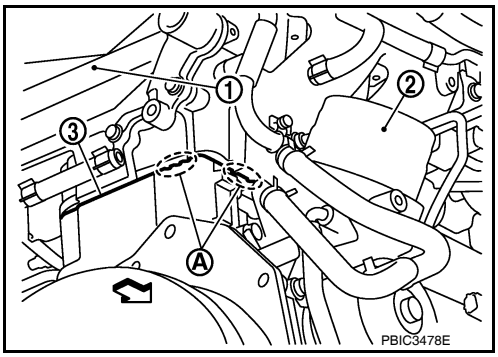


Gasket thickness[1] mm (in)	Number of grade[2]	Number of cut-outs
0.900 (0.0354)	1	0
0.925 (0.0364)	2	1
0.950 (0.0374)	3	2
0.975 (0.0384)	4	3
1.000 (0.0394)	5	4
1.025 (0.0404)	6	5

[1]: Measured with head bolts tightened

[2]: Always check with the Parts Department for the latest parts information

   - Gasket (3) thickness can be identified at the location (A) shown by the numbers of cut-outs before removal.



1 : Cylinder head rear cover
2 : Oil filter
⇦ : Front

   - Heater return tube is omitted for explanation.

NOTE:
Use mirrors for checking at points out of clear sight.

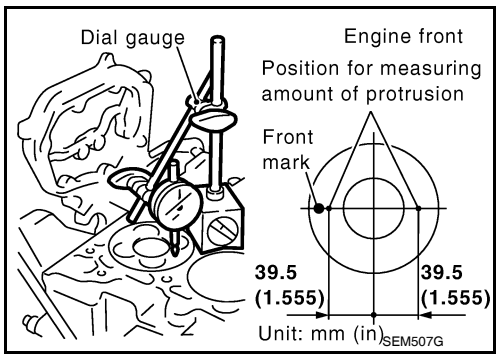
- **When the following parts have been repaired/replaced:**
- With cylinder block upper surface and/or crankshaft pin journal ground
- With cylinder block, pistons, connecting rods, and/or crankshaft replaced

a. Set piston at a point close to TDC.

b. Set the dial gauge at the location as shown. Turning crankshaft gradually, set the gauge scale to “0” where the piston protrusion is maximized.

c. Move the dial gauge stand so that the tip of dial gauge can contact cylinder block. Read the difference.

d. Measure two points from each cylinder in order to obtain each mean value of them. Choose a properly thick gasket corresponding the highest number of the four values.



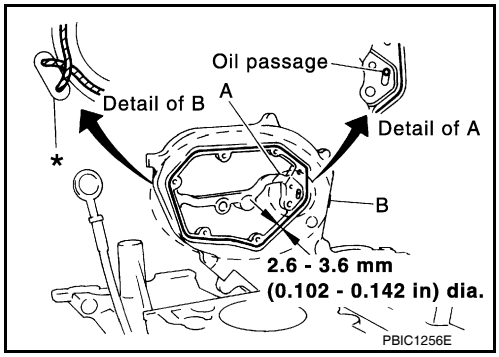
Piston protrusion mm (in)	Gasket thickness* mm (in)	Identification
		Number of cut-outs
0.230 - 0.255 (0.0091 - 0.0100)	0.900 (0.0354)	0
0.255 - 0.280 (0.0100 - 0.0110)	0.925 (0.0364)	1
0.280 - 0.305 (0.0110 - 0.0120)	0.950 (0.0374)	2
0.305 - 0.330 (0.0120 - 0.0130)	0.975 (0.0384)	3
0.330 - 0.355 (0.0130 - 0.0140)	1.000 (0.0394)	4
0.355 - 0.400 (0.0140 - 0.0157)	1.025 (0.0404)	5

*: Measured with head bolts tightened

e. If out of above protrusion, check replaced parts.

2. Apply a continuous bead of liquid gasket with the Tool as shown. **Use Genuine Liquid Gasket or equivalent. Refer to** **GI-43, "Recommended Chemical Product and Sealant"****.**
A: Apply bead so that it does not protrude into oil passage.
B: Minimize the overlapping area of the bead, with start and end areas of bead as shown.
Apply so that the portion marked * comes at an external location but cannot be viewed externally after engine is assembled.

Tool number : WS39930000

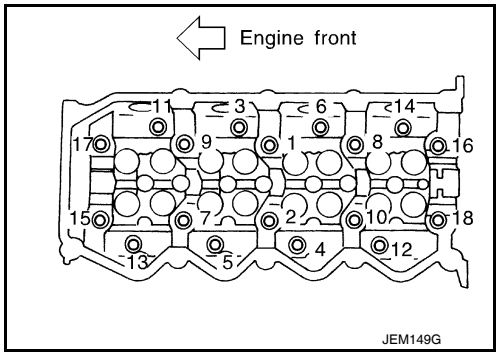


3. Install cylinder head assembly.
• Tighten bolts in numerical order as shown according to the following procedure:

a. Apply engine oil to bolt threads and seat surfaces.

b. Tighten all bolts.

: 39.2 N·m (4.0 kg-m, 29 ft-lb)

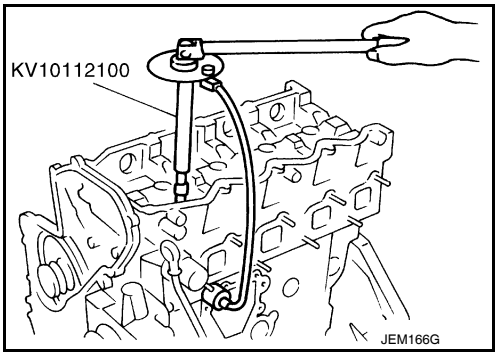


c. Tighten 180 degrees (angle tightening).
d. Loosen completely in the reverse order of that shown above.

: 0 N·m (0 kg-m, 0 ft-lb)

e. Tighten all bolts in numerical order as shown above.

: 39.2 N·m (4.0 kg-m, 29 ft-lb)



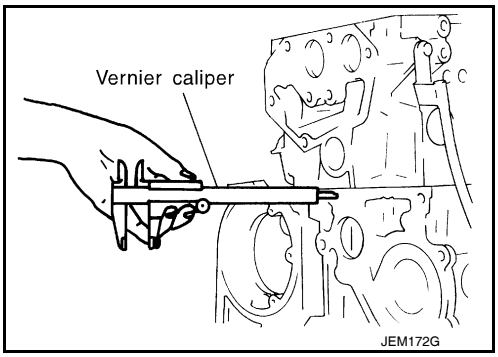
f. Tighten 90 degrees (angle tightening).
g. Tighten another 90 degrees (angular tightening).

CAUTION:
- **When the angle wrench is not used, paint an alignment mark on the head of cylinder head bolt and cylinder head surface before tightening. Check the angle with a protractor.**

4. Tighten bolts between rear chain case and cylinder head. Refer to EM-152, "Component".
5. After installing cylinder head, measure dimension from the front end surface of cylinder block to that of cylinder head (If rear chain case is removed).

Standard : 23.53 - 24.07 mm (0.9264 - 0.9476 in)

- If out of the standard, check fitting of dowel pins and cylinder head.



6. Install glow plug.

CAUTION:
- **To avoid damage, glow plugs should be removed only when required.**
- **Handle with care to avoid applying shock. When dropped from approx. 10 cm (3.94 in) or higher, always replace with a new one.**
- **Before installing, remove carbon depositing on mounting hole of glow plug with a reamer.**

7. Install engine coolant temperature sensor.
8. Installation is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following procedures are for checking fluid leaks, lubrication leaks and exhaust gas leaks.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to LU-18, "Inspection" and CO-32, "System Inspection".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable components, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level (*2)
Other oils and fluid (*1)	Level	Leakage	Level

Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

*1: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

*2: Check engine oil level 10 minutes after engine stopped.

Component

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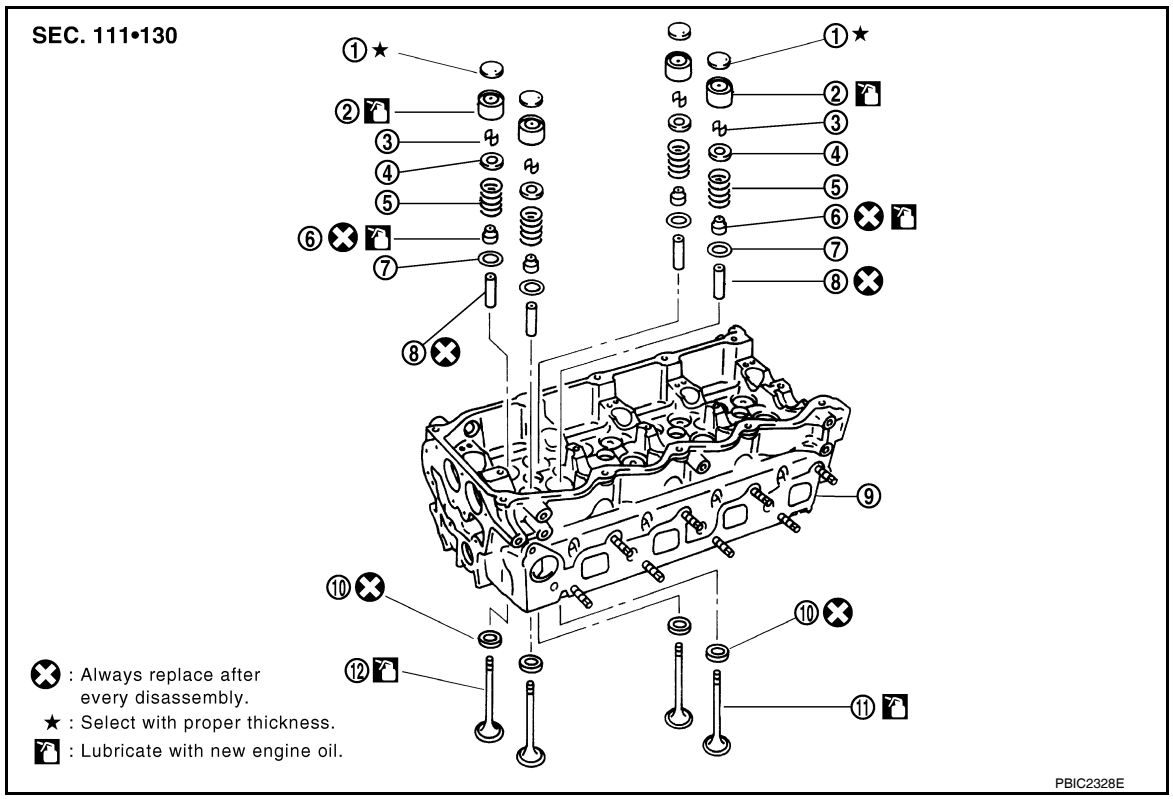


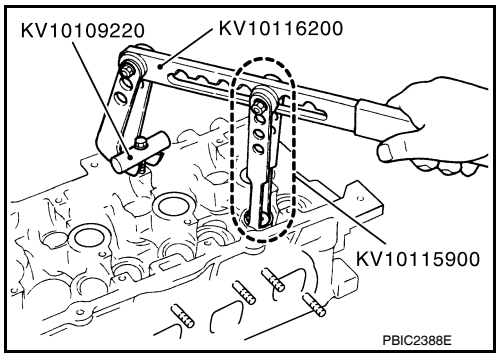
1. Adjusting shim
2. Valve lifter
3. Valve collet
4. Valve spring retainer
5. Valve spring
6. Valve oil seal
7. Valve spring seat
8. Valve guide
9. Cylinder head
10. Valve seat
11. Valve (Exhaust)
12. Valve (Intake)

Disassembly and Assembly

INFOID:0000000006927542

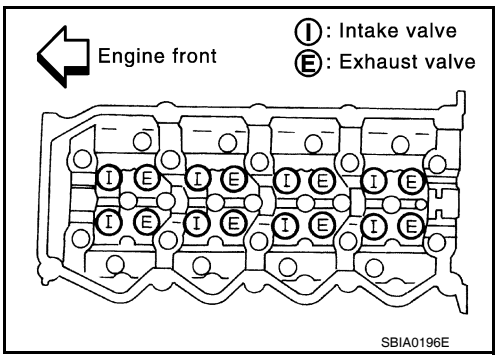
DISASSEMBLY

1. Remove adjusting shims and valve lifters.
   • Record the installation positions for assembly to original locations.
2. Remove valve collet.
   • Use the Tool to compress valve spring. Use a magnet hand to remove valve collets.

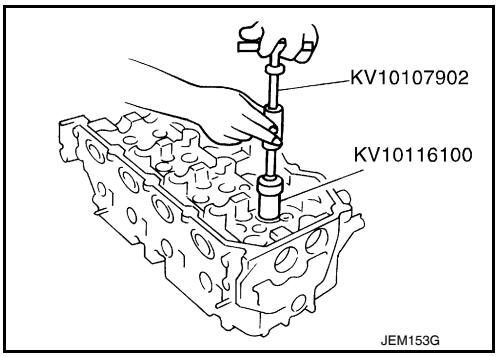


3. Remove valve spring retainers and valve springs.
4. Remove valves by pressing valve stems toward combustion chamber.

- Before removing valve, check the valve guide clearance.
  NOTE:
  Intake and exhaust valve positions are as shown. Intake and exhaust valve driving cams are provided alternately for each camshaft.

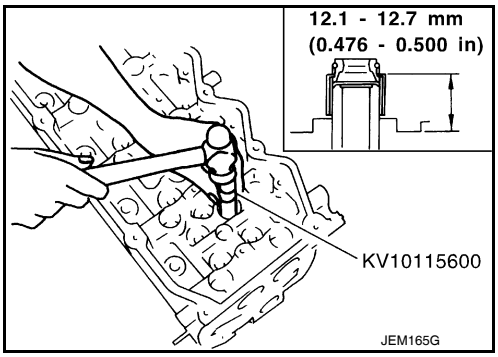


5. Remove valve oil seals using the Tool.
6. Remove valve spring seats.
7. Before removing valve seats, perform valve seat contact check.
8. Before removing valve guides, perform valve guide clearance check.

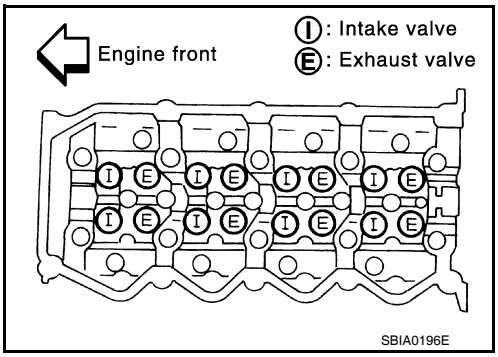


ASSEMBLY

1. Install valve guides.
2. Install valve seats.
3. Use Tool to install valve oil seals following the dimension shown.
4. Install valve spring seats.

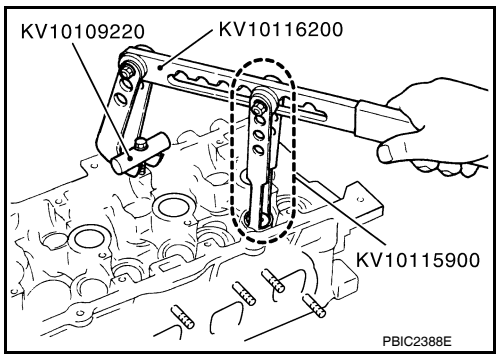


5. Install valves.
   - Install the valves with bigger outer diameter to intake valve side.
   - Note that valve layout here is different from that of conventional engine.



6. Install valve spring.
7. Install valve spring retainers.

8. Use the Tool to compress valve springs.
Then install valve collets using magnet hand.
• After installing valve collets, tap the stem end using the plastic hammer, and check the installation status.

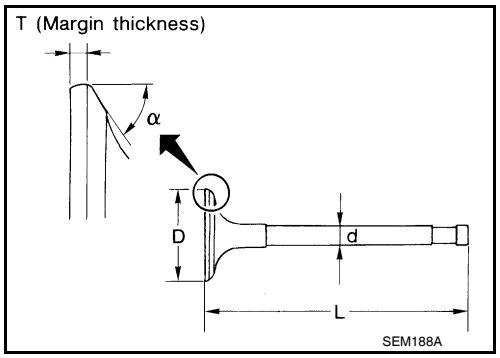


9. Install valve lifters and adjusting shims to the original positions.

INSPECTION AFTER DISASSEMBLY

Valve Dimension

• Check dimensions of each valve. For dimensions, refer to EM-202, "Standard and Limit".
• If dimensions are out of the standard, replace valve.



Valve Guide Clearance

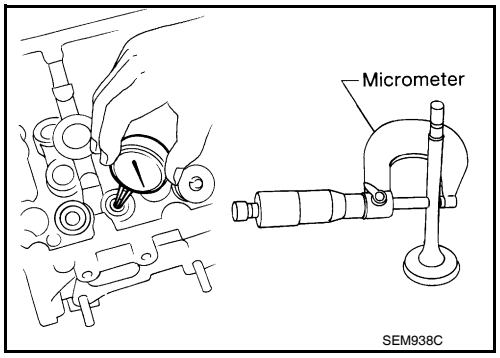
Valve Stem Diameter

• Measure diameter of valve stem with micrometer.

Standard

Intake : 5.965 - 5.980 mm (0.2348 - 0.2354 in)

Exhaust : 5.945 - 5.960 mm (0.2341 - 0.2346 in)



Valve Guide Inner Diameter

• Measure inner diameter of valve guide with inside micrometer.

Standard

Intake and Exhaust : 6.000 - 6.018 mm (0.2362 - 0.2369 in)

Valve Guide Clearance

• (Valve guide clearance) = (Valve guide inner diameter) – (Valve stem diameter).

Valve guide clearance:

Standard

Intake : 0.020 - 0.053 mm (0.0008 - 0.0021 in)

Exhaust : 0.040 - 0.073 mm (0.0016 - 0.0029 in)

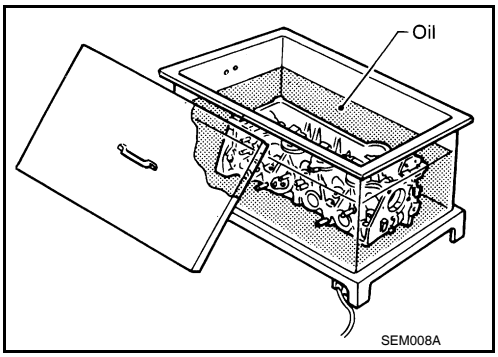
Limit

Intake : 0.08 mm (0.0031 in)
Exhaust : 0.10 mm (0.0039 in)

- If it exceeds the limit, replace valve and/or valve guide.

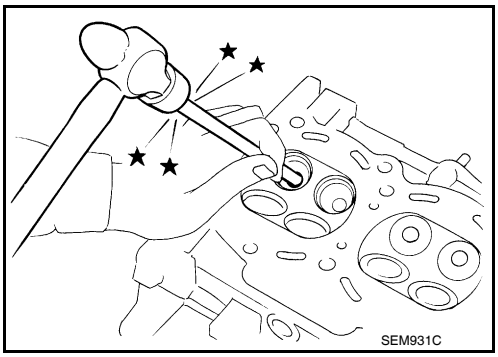
Valve Guide Replacement
When removing valve guide, replace it with oversized [0.2 mm (0.0008 in)] valve guide.

1. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.



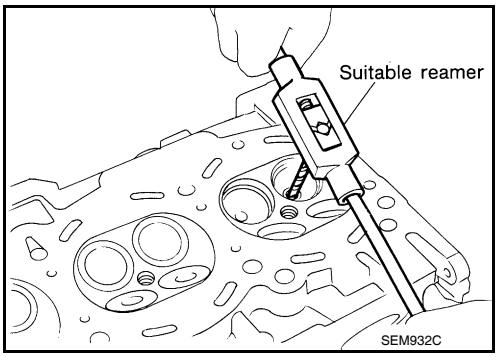
2. Using the valve guide drift, tap valve guides out from the combustion chamber side.

WARNING:
Cylinder head contains heat, when working, wear protective equipment to avoid getting burned.

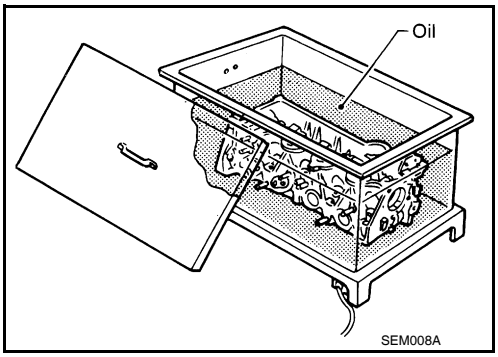


3. Ream cylinder head valve guide hole with the valve guide reamer.

Valve guide hole diameter (for service parts):
10.175 - 10.196 mm (0.4006 - 0.4014 in)



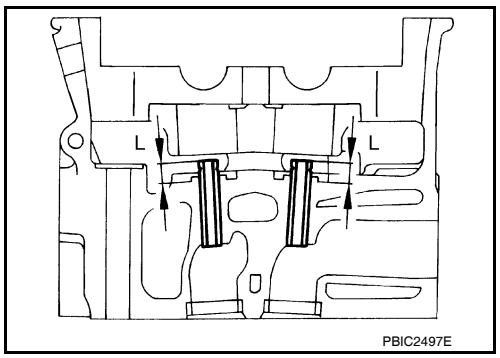
4. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.



5. Using the valve guide drift, press fit valve guides from camshaft side, referring to the dimension shown.

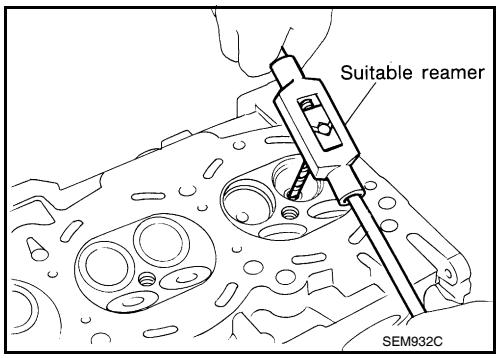
Projection "L" : 10.4 - 10.6 mm (0.409 - 0.417 in)

WARNING:
Cylinder head contains heat, when working, wear protective equipment to avoid getting burned.



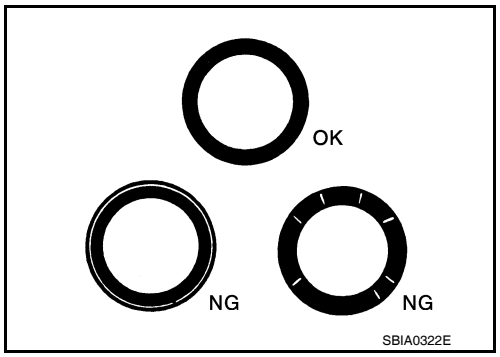
6. Using the valve guide reamer, perform reaming to the press-fitted valve guides.

Reaming specifications:
Intake and Exhaust
6.000 - 6.018 mm (0.2362 - 0.2369 in)



Valve Seat Contact

- Before starting this check, confirm that the dimension of valve guide and valves are as specified.
- Apply red lead primer on contacting surfaces of valves seat and of valve face to examine the conditions of contacting surfaces.
- Make sure that the paint on contacting surfaces is continuous along the entire circumference.
- If there are abnormal indications, grind the valve and check the contact again. If malfunction indications still persist, replace valve seat.



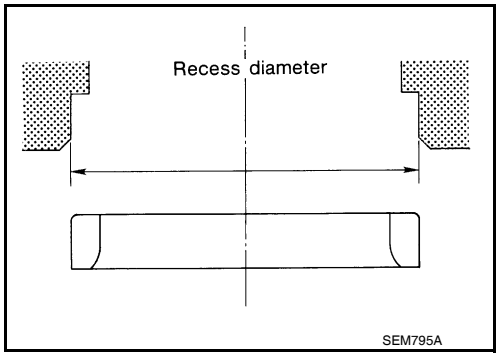
Valve Seat Replacement

When removing valve seat, replace it with oversized [0.5 mm (0.020 in)] valve seat.

1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to EM-202, "Standard and Limit".
2. Ream cylinder head recess diameter for service valve seat.

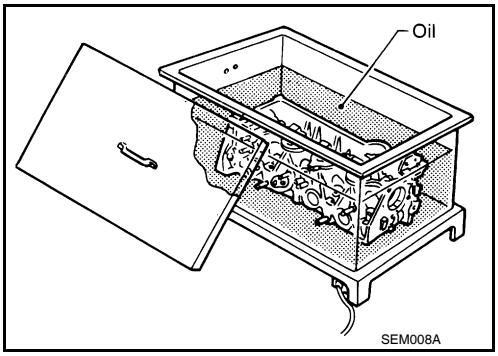
Oversize [0.5 mm (0.020 in)]:
Intake : 30.500 - 30.516 mm (1.2008 - 1.2014 in)
Exhaust : 29.500 - 29.516 mm (1.1614 - 1.1620 in)

- Be sure to ream in circles concentric to the valve guide center.
- This will enable valve seat to fit correctly.



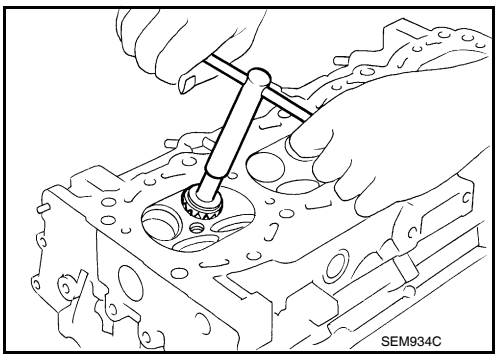
3. Heat cylinder head to approximately 110 to 130°C (230 to 266°F) in oil bath.
4. After cooling valve seats sufficiently with dry ice, press fit it to cylinder head.

WARNING:
Cylinder head contains heat, when working, wear protective equipment to avoid getting burned.
CAUTION:
Do not touch the cooled valve seats directly by hand.



5. Using the valve seat cutter set, finish processing to specification. Refer to EM-202, "Standard and Limit".

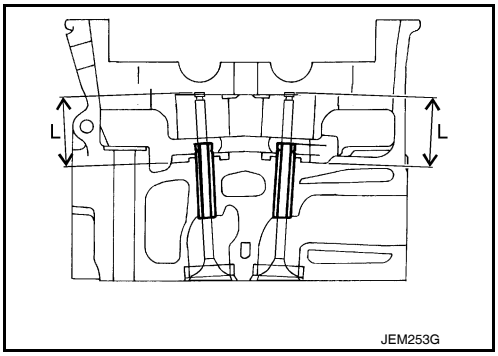
CAUTION:
When using the valve seat cutter set, grasp cutter handle with both hands, press cutter onto contacting face all around, and cut thoroughly. If cutter is pressed unevenly or repeatedly, the valve seat surface may be damaged.



6. Using compound, perform valve fitting.
7. Check again to make sure that contacting status is satisfactory.
8. Use the depth gauge to measure the distance between the mounting surface of cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace valve seat with a new one.

Valve seat resurface limit "L":

Intake	**: 36.53 - 36.98 mm (1.4382 - 1.4559 in)**
Exhaust	**: 36.53 - 37.01 mm (1.4382 - 1.4571 in)**

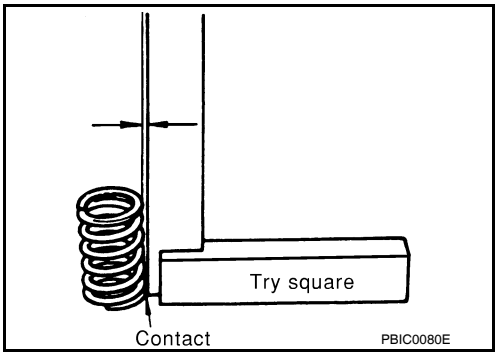


Valve Spring Square

- Position the try square to valve spring, turn the spring, and measure the maximum clearance value between top surface of spring and the try square.

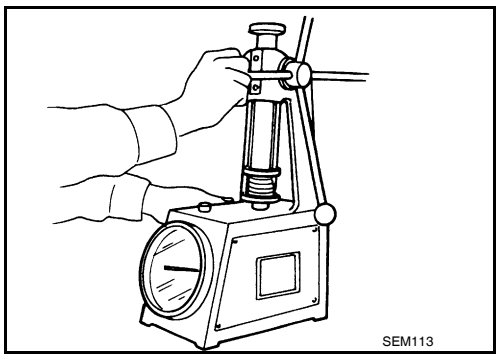
Limit : 1.9 mm (0.075 in)

- If it exceeds the limit, replace valve spring.



Valve Spring Dimensions and Valve Spring Pressure Load

- Using valve spring tester, check the following.



Standard:

Free height	**: 44.74 mm (1.76 in)**
Installation height	**: 32.82 mm (1.2921 in)**
Installation load	**: 184 - 208 N (18.77 - 21.22 kg, 41.4 - 46.8 lb)**
Height during valve open	**: 24.82 mm (0.9772 in)**
Load with valve open	**: 320 - 360 N (32.65 - 36.73 kg, 71.9 - 80.9 lb)**

- If out of the standard, replace the valve spring.

ENGINE ASSEMBLY

Component

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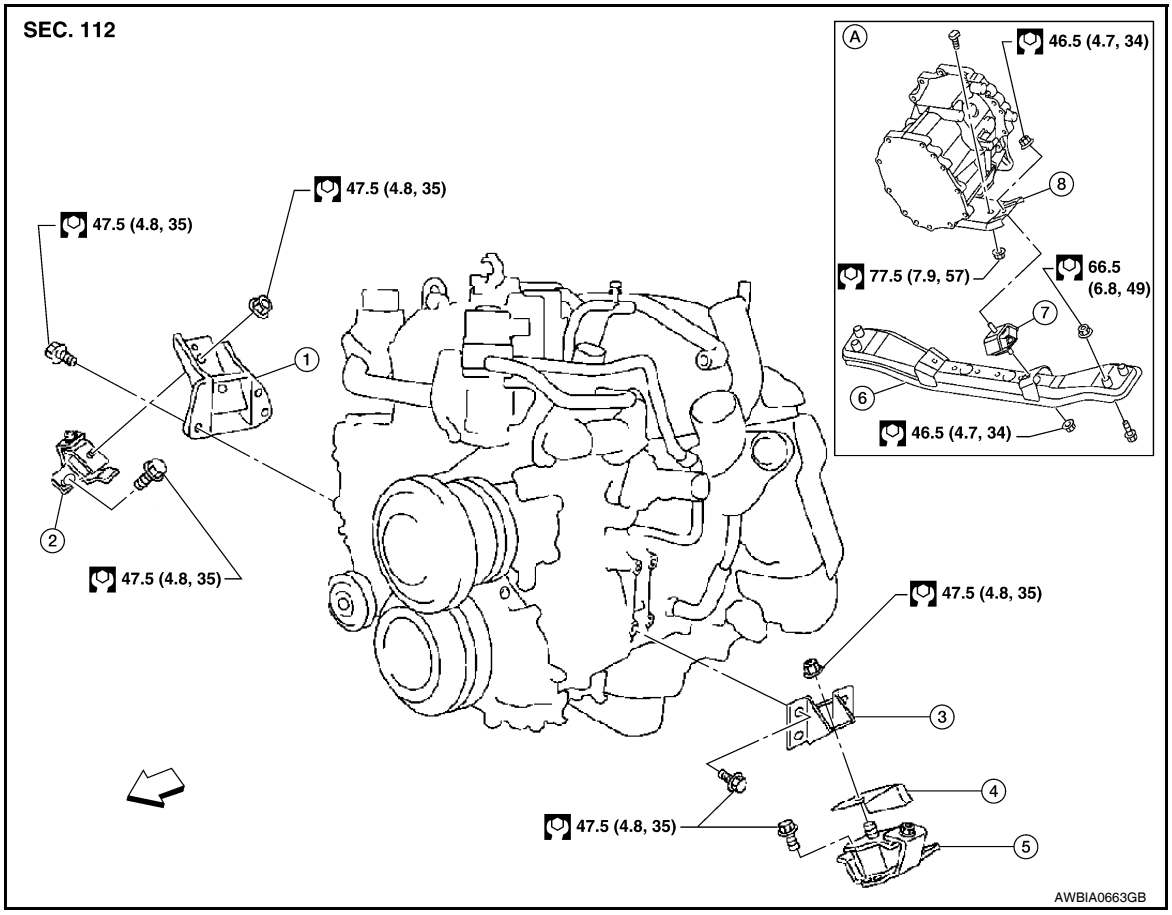


1. RH engine mounting bracket
2. RH engine mounting insulator
3. LH engine mounting bracket
4. Heat insulator
5. LH engine mounting insulator
6. Transmission cross member
7. Engine mounting insulator (rear)
8. Transmission sub-member
A. Rear engine mount

Removal and Installation

INFOID:0000000006927544

WARNING:
- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**
- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Do not start working until exhaust system and engine coolant are cool enough.**

CAUTION:
- **If items or work required are not covered by the engine main body section, follow the applicable procedures.**
- **Always use the support point specified for lifting.**
- **Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.**
- **For supporting points for lifting and jacking point at rear axle, refer to GI-38, "Lifting Points".**

REMOVAL

Description of work

Remove transmission assembly, if required, from vehicle downward. Then hoist the engine from vehicle upward.

Preparation

1. Disconnect battery cable from negative terminal. Refer to SC-6, "Removal and Installation".
2. Drain engine coolant from radiator. Refer to CO-33, "Changing Engine Coolant".
3. Remove the following parts.
   - Hood assembly; Refer to BL-11, "Removal and Installation of Hood Assembly".
   - Air cleaner and air duct; Refer to EM-90, "Component".
   - Engine undercover
   - Radiator and radiator shroud (upper and lower); Refer to CO-35, "Removal and Installation".
   - Cooling fan (crankshaft driven type) and fan coupling; Refer to CO-38, "Removal and Installation".
   - Drive belts; Refer to EM-88, "Checking Drive Belts".
   - Charge air cooler; Refer to EM-92, "Removal and Installation".
4. Disconnect engine room harness from the engine side and set it aside for easier work.
5. Disconnect all the body-side vacuum hoses and air hoses at engine side.

Engine room RH

1. Disconnect heater hose, and install plug it to prevent engine coolant from draining. Refer to CO-42, "Component".
2. Disconnect fuel feed hose and return hose, and plug it to prevent fuel from draining. Refer to EM-117, "Component".
3. Remove power steering pump, if equipped and position aside. Refer to PS-13, "Description".

Engine room LH

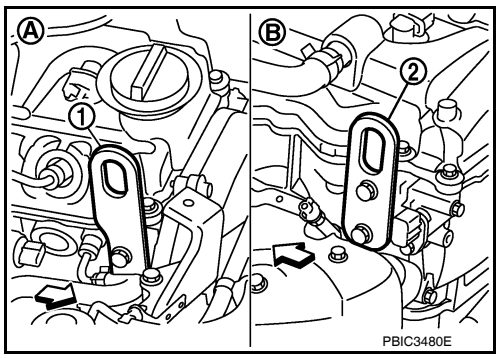
1. Remove A/C compressor (if equipped) with piping connected from engine. Temporarily secure it on body with a rope to avoid putting load on it. Refer to MTC-68, "Removal and Installation for Compressor".

Vehicle underbody

1. Remove front tires LH and RH. Refer to WT-5, "Adjustment".
2. Remove wheelhouse rubber RH.
3. Remove starter motor. Refer to SC-14, "Removal and Installation".
4. Remove front final drive (4WD models). Refer to FFD-10, "Removal and Installation".
5. Remove exhaust front tube. Refer to EX-4, "Exploded View".
6. Remove transmission assembly (2WD models only). Refer to MT-52, "Removal and Installation".

Removal

1. Install engine slingers into front right of cylinder head (A) and rear left of cylinder head (B).



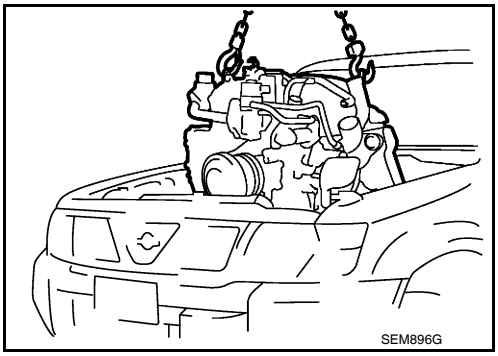
1 : Engine slinger (front)
2 : Engine slinger (rear)
⇦ : Front

Engine slinger bolts:

: 28.0 N·m (2.9 kg-m, 21 ft-lb)

2. Lift with hoist and secure engine in position.
3. Loosen LH and RH engine mounting insulator nuts.

4. Remove engine.
CAUTION:
- **During the operation, make sure that no part interferes with body side.**
- **Before and during this lifting, always check if any harnesses are left connected.**



INSTALLATION

Installation is in the reverse order of removal.
- Do not allow engine oil to get on mounting insulator. Be careful not to damage mounting insulator.
- When installation directions are specified, install parts according to the direction marks on them referring to figure of components. Refer to EM-176, "Component".
- Make sure that each mounting insulator is seated properly, and tighten bolts and nuts.
- Insert vacuum hose to vacuum gallery until vacuum hose comes in contact with the stopper when a stopper is provided at vacuum gallery.
- Insert vacuum hose up to 15 mm (0. 59 in) when a stopper is not provided at vacuum gallery.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following procedures are for checking fluid leaks, lubrication leaks and exhaust gas leaks.
- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to LU-18, "Inspection" and CO-32, "System Inspection".
- Use procedure below to check for fuel leakage.
- Before starting engine, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable components, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level (*2)
Other oils and fluid (*1)	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

*1: Transmission/transaxle/AT fluid, power steering fluid, brake fluid, etc.

*2: Check engine oil level 10 minutes after engine stopped.

CYLINDER BLOCK

Component

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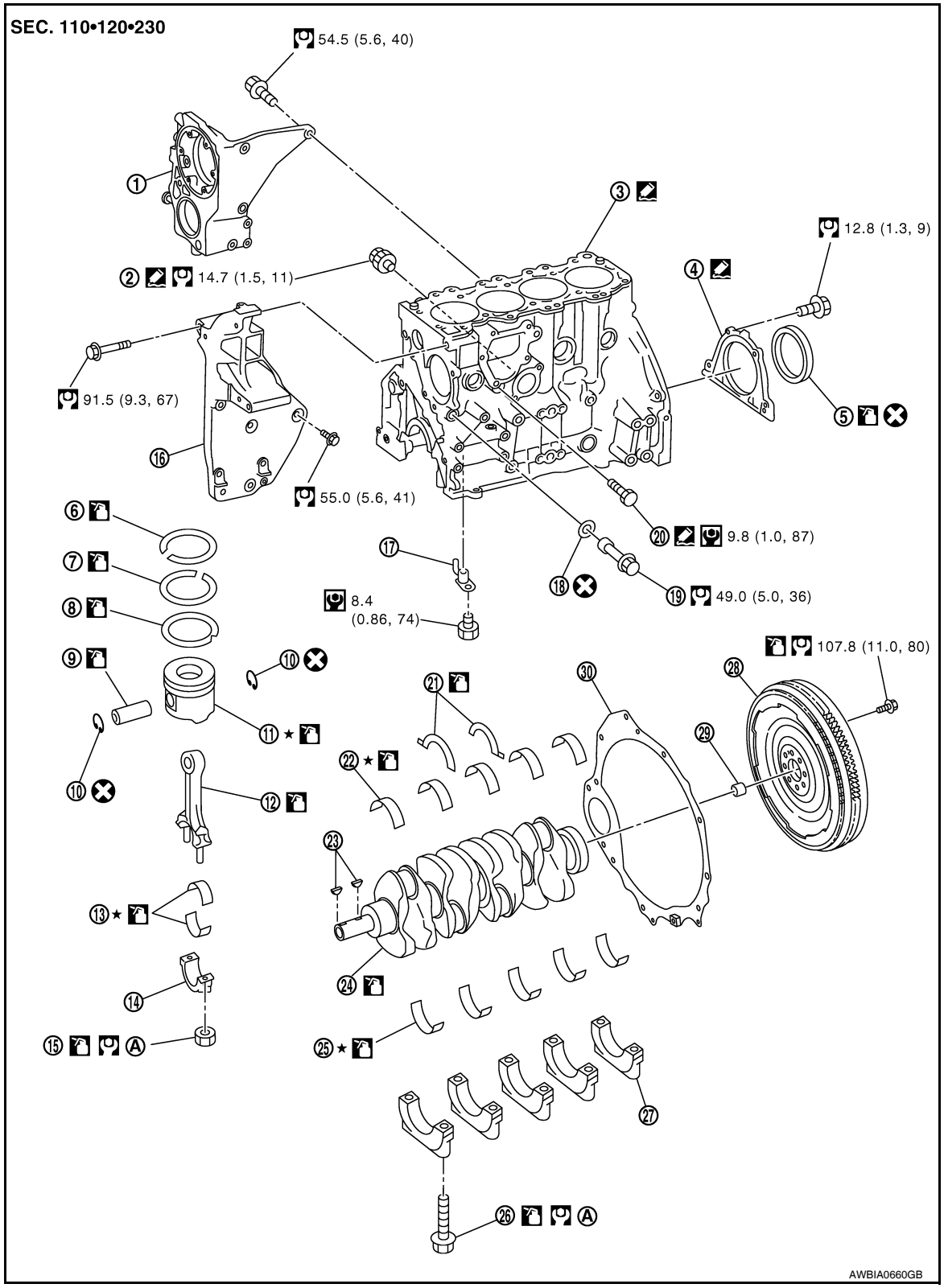


1. Fuel pump bracket
2. Oil pressure switch
3. Cylinder block
4. Rear oil seal retainer
5. Rear oil seal
6. Top ring
7. Second ring
8. Oil ring
9. Piston pin

10. Snap ring
11. Piston
12. Connecting rod
13. Connecting rod bearing
14. Connecting rod cap
15. Connecting rod nut
16. A/C compressor bracket
17. Oil jet
18. Copper washer
19. Oil jet relief valve
20. Drain plug
21. Thrust bearing
22. Main bearing upper
23. Key
24. Crankshaft
25. Main bearing lower
26. Main bearing cap bolt
27. Main bearing cap
28. Flywheel
29. Pilot bushing
30. Rear plate

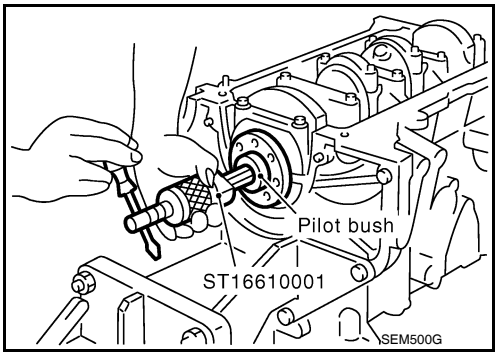
A. Refer to EM-180.

Disassembly and Assembly

INFOID:0000000006927546

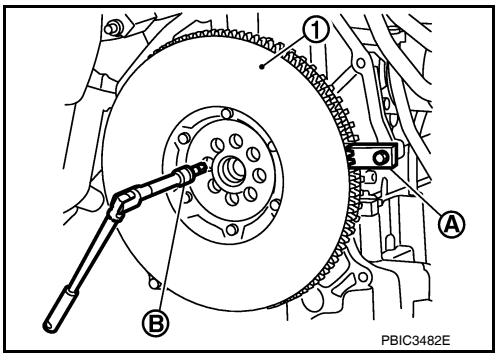
DISASSEMBLY

1. Remove engine from the vehicle. Refer to EM-176, "Component".
2. Remove clutch cover and disc. Refer to CL-16, "Removal and Installation".
3. Remove pilot bushing, if necessary.
   - Use the Tool to remove the pilot bushing from rear end of crankshaft.



4. Install engine to engine stand as follows.

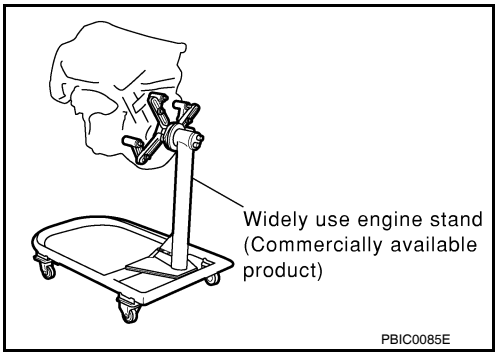
a. Remove flywheel.
   - Secure ring gear with the Tool (A), then loosen bolts with Tool (B) and remove them. As an alternative method hold crankshaft pulley with a suitable tool to remove flywheel (1).



   1 : Flywheel
   A : KV10105630
   B : TORX bit (size: T55)

   CAUTION:
   - **Do not disassemble flywheel.**
   - **Do not place flywheel with signal plate facing down.**
   - **When handling signal plate, take care not to damage or scratch it.**
   - **Handle signal plate in a manner that prevents it from becoming magnetized.**

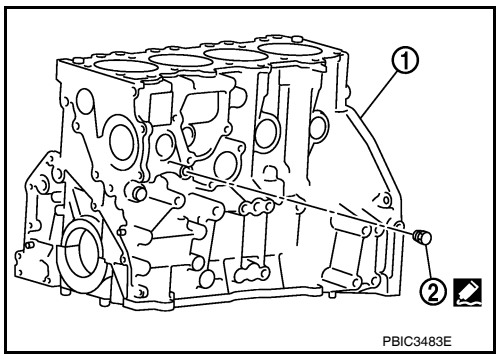
b. Lift engine and install it to a suitable engine stand.
   NOTE:
   The illustration shows an example of general-purpose engine stand that can hold mating surface of transmission with flywheel and rear plate removed.



5. Drain engine oil. Refer to LU-19, "Changing Engine Oil".

6. Drain engine coolant by removing drain plug from side of cylinder block.

1 : Cylinder block
2 : Drain plug



7. Remove the following parts and related parts. (Only major parts are listed.)
- Intake manifold (Refer to EM-93, "Component".)
- Turbocharger (Refer to EM-100, "Component".)
- Exhaust manifold (Refer to EM-105, "Component".)
- Rocker cover (Refer to EM-129, "Component".)
- Fuel injector (Refer to EM-117, "Component".)
- Oil pan and oil strainer (Refer to EM-108, "Component".)
- Water pump (Refer to CO-40, "Component".)
- Thermostat and water piping (Refer to CO-42, "Component".)
- Secondary timing chain (Refer to EM-146, "Component".)
- Primary timing chain (Refer to EM-152, "Component".)
- Fuel pump (Refer to EM-122, "Component".)
- Vacuum pump (Refer to EM-115, "Component".)
- Camshaft (Refer to EM-132, "Component".)
- Cylinder head (Refer to EM-164, "Component".)
- Oil cooler (Refer to LU-23, "Component".)
- Accessory, accessory bracket and mount brackets

8. Remove fuel pump bracket.
9. Remove rear oil seal retainer.
- Insert a suitable tool between main bearing cap and rear oil seal retainer to remove retainer.

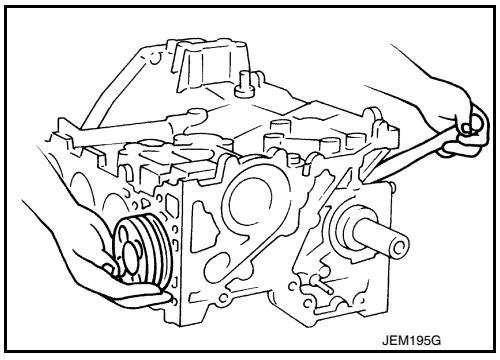
10. Remove rear oil seal from rear oil seal retainer. Refer to EM-144, "Removal and Installation of Rear Oil Seal".
- Punch out with a suitable tool.

CAUTION:
Be careful not to damage rear oil seal retainer.

11. Remove piston and connecting rod assembly.
- Before removing piston and connecting rod assembly, check connecting rod side clearance. Refer to EM-192, "Inspection After Disassembly".

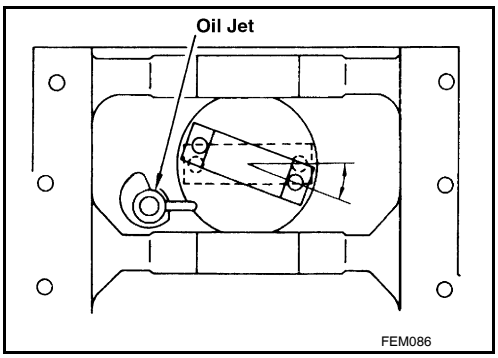
a. Move crankshaft pin to be removed to approximately BDC.
b. Remove connecting rod caps.
c. Using the grip of a hammer, press the piston and connecting rod assembly out to cylinder head side.

CAUTION:
- **Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.**



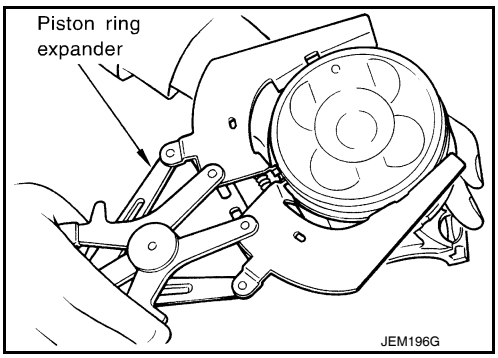
- **When removing piston and connecting rod assembly, prevent the big end of connecting rod from interfering with oil jet.**

12. Remove connecting rod bearings from connecting rods and caps.
    - Keep them by cylinder to avoid confusion.



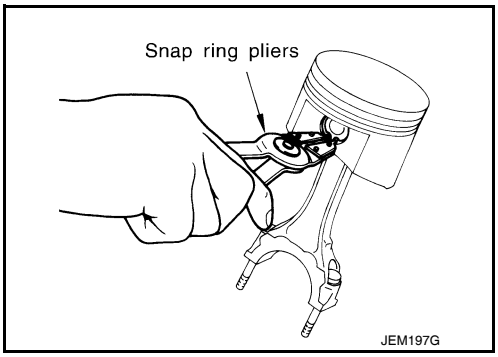
13. Remove piston rings from pistons using a suitable piston ring expander.

    CAUTION:
    - **When removing, prevent pistons from being damaged.**
    - **Do not expand piston rings excessively. This may damage piston rings.**

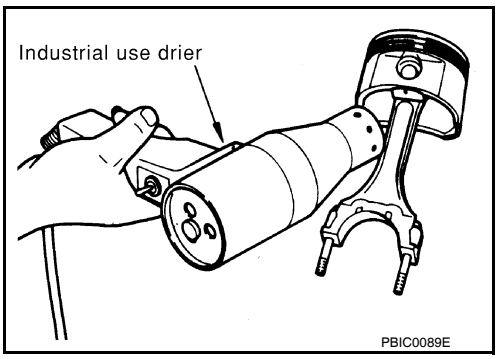


14. Remove pistons from connecting rods.

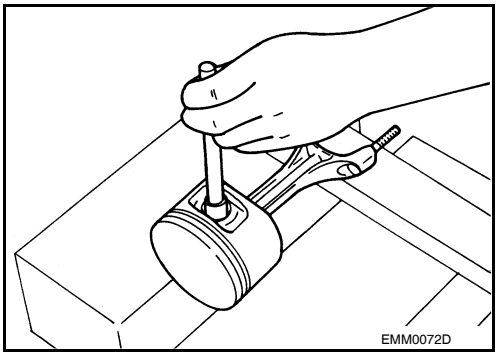
a. Using the snap ring pliers, remove snap rings.



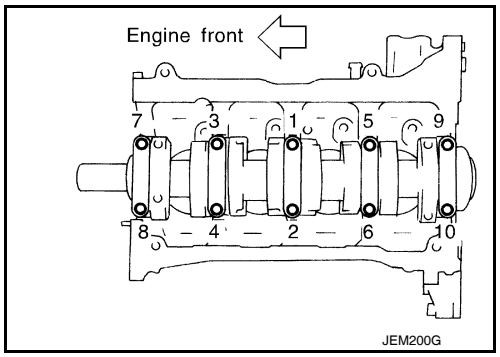
b. Using the industrial use dryer, heat pistons up to 60 to 70°C (140 to 158°F).



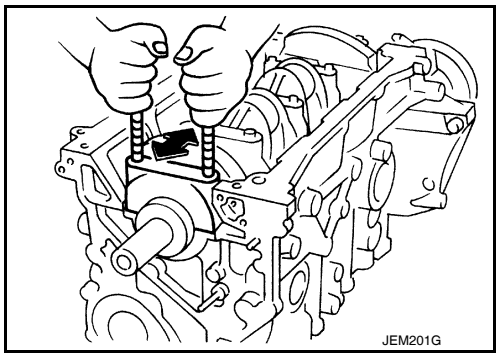
c. Using rod with outer diameter of 26 mm (1.02 in), press piston pins out.



15. Remove main bearing cap bolts.
    - With a TORX socket (size: E14I), loosen main bearing cap bolts in several stages in the reverse order of that shown and remove them.
    - Before loosening main bearing cap bolts, measure crankshaft end play. Refer to EM-192, "Inspection After Disassembly".

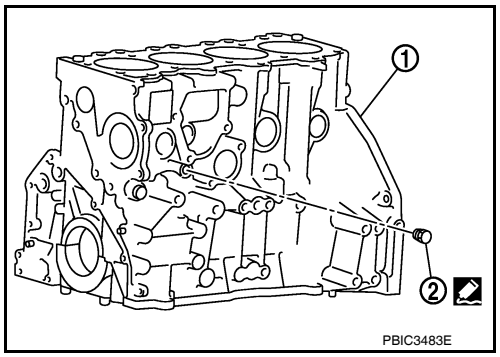


16. Remove main bearing caps.
    - Using main bearing cap bolts, remove by rocking bearing cap back and forth.
17. Remove crankshaft.
18. Remove main bearings and thrust bearings from cylinder block and main bearing caps.
    CAUTION:
    Check the correct installation locations of removed parts. Store them so they do not get mixed up.
19. Remove oil jet.
20. Remove oil jet relief valve.

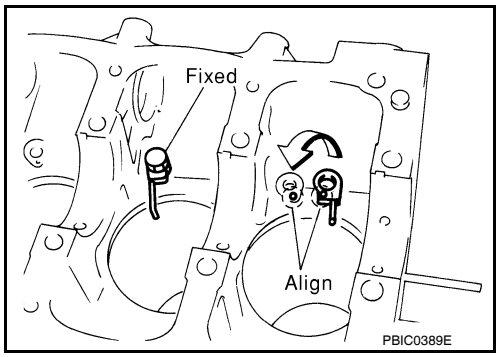


ASSEMBLY

1. Blow air sufficiently to inside engine coolant passage, engine oil passage, crankcase and cylinder bore to remove foreign matter.
   CAUTION:
   Use goggles to protect your eyes.
2. Install drain plug (2) to cylinder block (1).
   - Apply liquid gasket to drain plug.
     Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".



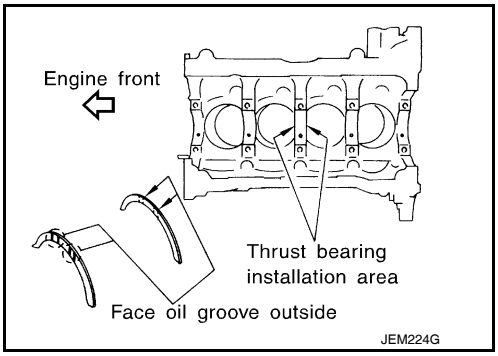
3. Install oil jet relief valve.
4. Install oil jet.
   - Align knock pin on back of oil jet with hole on cylinder block when installing oil jet.



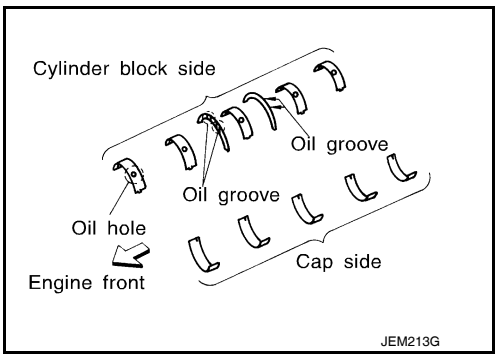
5. Install main bearings and thrust bearings.

a. Remove contamination, dust and engine oil from bearing mounting positions on cylinder block and main bearing caps.

b. Install thrust bearings on both sides of No. 3 housing on cylinder block.
- Install thrust bearings with oil groove facing to crankshaft arm (outside).



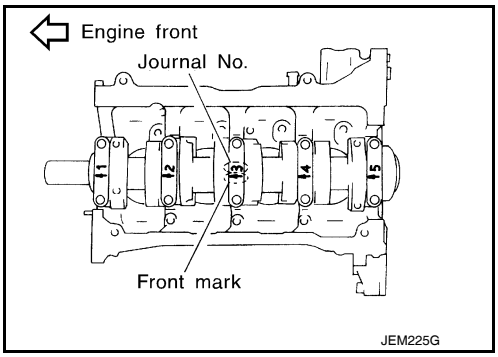
c. Being careful with the direction, install main bearings.
- Install main bearings with the oil holes and grooves onto the cylinder block side, and those without oil holes and grooves onto the main bearing cap side.
- While installing bearings, apply engine oil to bearing surfaces (inside). Do not apply engine oil to rear surfaces, but clean them completely.
- Align stopper notches on bearings to install them.
- Make sure that the oil holes on the cylinder block body are mated with the oil hole positions on the bearings.



6. Install crankshaft to cylinder block.
- Make sure crankshaft rotates smoothly by hand.

7. Install main bearing caps.
- Identify main bearing caps by the punched mark. Install correctly matching the journal No. on the bearing cap and the journal with the front mark facing forward.
- Main bearing caps are commonly processed with the cylinder block. Therefore, caps and cylinder block should be replaced as a set.

8. Check the main bearing cap bolts for deformation. Refer to EM-192, "Inspection After Disassembly".

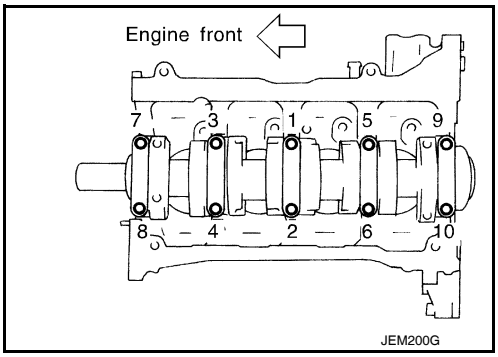


9. With the TORX socket (size: E14), tighten the main bearing cap bolts according to the following procedure:

a. Apply engine oil to the threaded part and seat surface of each bolt.

b. Tighten all bolts in numerical order shown.

: 27.0 N·m (2.8 kg-m, 20 ft-lb)



c. Put alignment marks (with paint) on each bolt and the main bearing cap, all in the same direction. (When using a protractor)

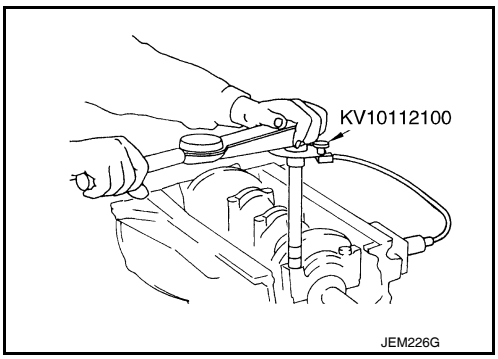
d. Then, tighten 90 degrees. (angle tightening)

CAUTION:

Always use either the Tool or protractor during angular tightening. Avoid tightening based on visual checks alone.
- After tightening bolts to specification, make sure that crankshaft rotates smoothly.
- Check crankshaft end play. Refer to EM-192, "Inspection After Disassembly".

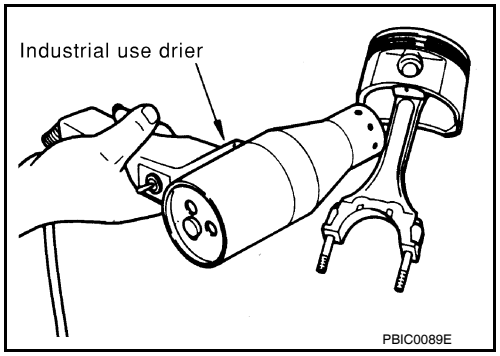
10. Check the outer diameter of connecting rod bolts. Refer to EM-192, "Inspection After Disassembly".

11. Install piston to connecting rod.

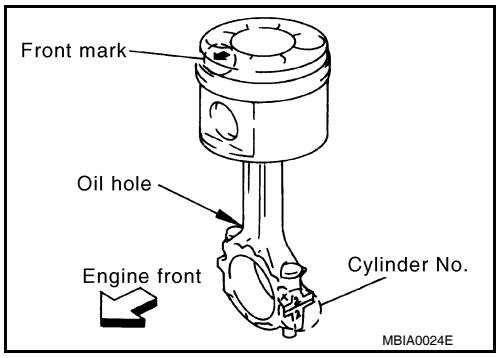


a. Using the snap ring pliers, install snap rings to groove on piston rear side.
   • Fit snap ring correctly into grooves.

b. Install pistons to connecting rods.
   • Using the industrial use dryer, heat pistons up to approx. 60 to 70°C (140 to 158°F) until piston pin can be pressed down by finger touch. Then insert piston pin into piston and connecting rod from front side of piston toward rear.



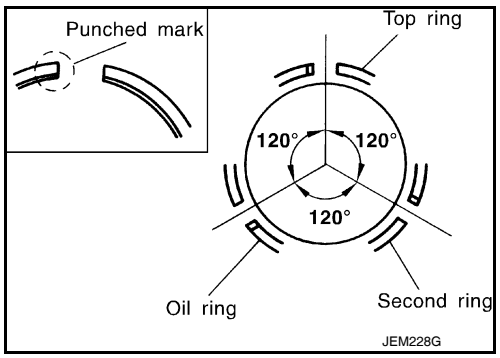
   • Assemble piston and connecting rod with front mark of piston head and cylinder No. stamped on connecting rod being positioned as shown.



c. Install snap ring to front side of piston.
   • Fit snap ring correctly into grooves.
   • After installation, check connecting rods for smooth movement.

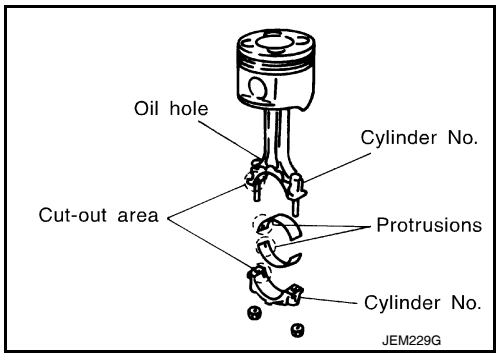
12. Use a suitable piston ring expander to install piston rings.
CAUTION:
When installing, prevent piston from being damaged.
   • Install top ring and second ring with punched mark surfaces facing upward.

Punched mark:
Top ring : RTOP
Second ring : R2ND



   • Install rings so that the closed gap positions are 120 degrees apart from one another.
   • Closed gaps do not need to face in a specific directions, as long as each are positioned 120 degrees apart.

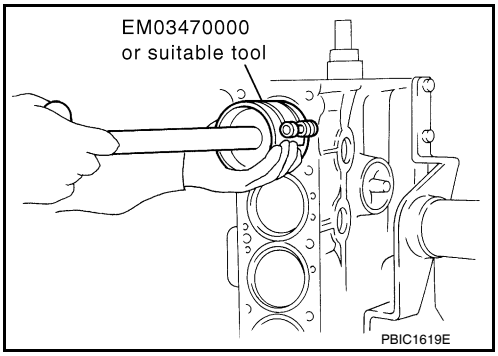
13. Install connecting rod bearing to connecting rod and cap.
   • While installing connecting rod bearing, apply engine oil to bearing surfaces (inside). Do not apply engine oil to rear surfaces, but clean them completely.
   • Align protrusions on connecting rod bearings with connecting rod cut-outs to install connecting rod bearings.



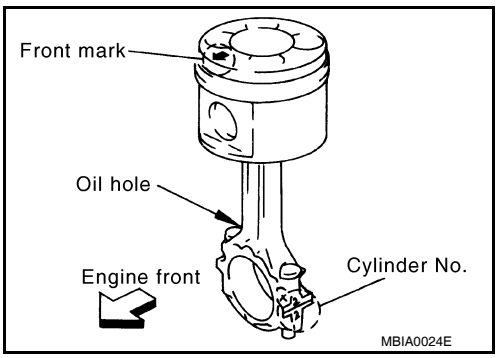
14. Install piston and connecting rod assembly to crankshaft.
    - Move crankshaft pin to be assembled to BDC.
    - Align cylinder position with cylinder No. on connecting rod to install piston and connecting rod assembly.
    - Using the Tool or suitable tool, install piston and connecting rod assembly with front mark on piston head facing toward the front side of engine.

    CAUTION:

    When installing piston and connecting rod assembly, prevent the big end of connecting rod from interfering with oil jet.



15. Install connecting rod caps and nuts.
    - Align cylinder No. stamped on connecting rod with that on cap to install connecting rod cap.
    - Make sure that the front mark on connecting rod cap faces towards the front of the engine.



16. Tighten connecting rod nuts according to the following procedure:

a. Apply engine oil on bolt threads and seat surface of nuts.

b. Tighten bolts.

Bolt : 29.4 N·m (3.0 kg-m, 22 ft-lb)

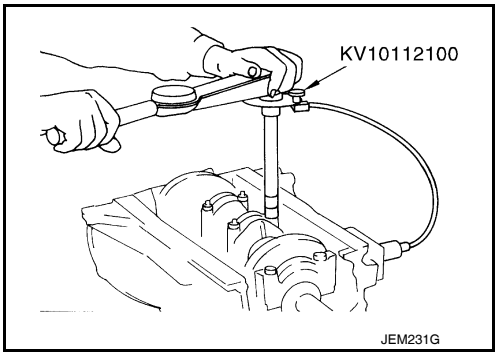
c. Loosen completely.

Bolt : 0 N·m (0 kg-m, 0 in-lb)

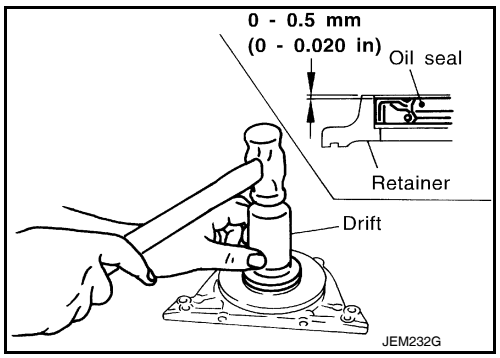
d. Tighten bolts.

Bolt : 19.6 N·m (2.0 kg-m, 14 ft-lb)

e. Tighten 120 degrees. (angle tightening)
    - **Always use either the Tool or protractor during angular tightening. Avoid tightening based on visual checks alone.**
    - After tightening nuts, make sure that crankshaft rotates smoothly.
    - Check connecting rod side clearance. Refer to EM-192, "Inspection After Disassembly".



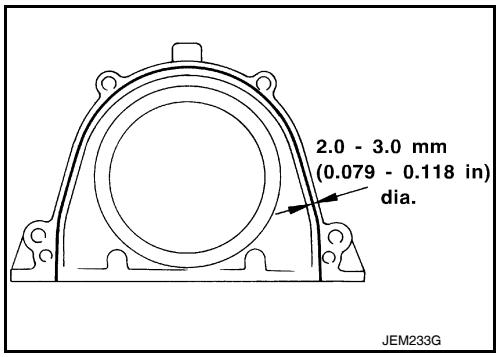
17. Press fit rear oil seal into rear oil seal retainer.
    - Using the drift [105 mm (4.13 in) dia.], press fit so that the dimension is as specified.
    - Avoid inclined fitting. Force fit perpendicularly.



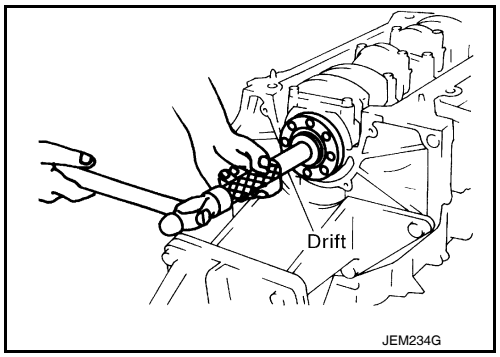
18. Install rear oil seal retainer to cylinder block.
    - Apply new engine oil to the oil and dust seal lips.
    - Apply liquid gasket to rear oil seal retainer using Tool as shown.

    Tool number : WS39930000

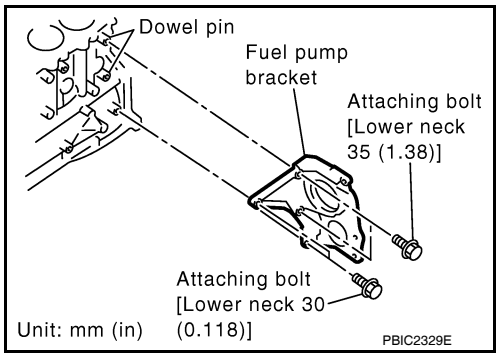
    Use Genuine Liquid Gasket or equivalent. Refer to GI-43, "Recommended Chemical Product and Sealant".



19. Press fit pilot bushing into crankshaft.
    - Using the drift with outer diameter of 19 mm (0.75 in), press fit pilot bushing until it stops.



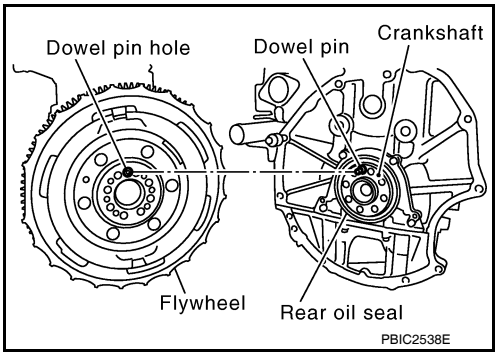
20. Install fuel pump bracket.
    - Align the bracket with the dowel pins on cylinder block to install.
    - The two bolts used for dowel pins have longer shanks than the other two.



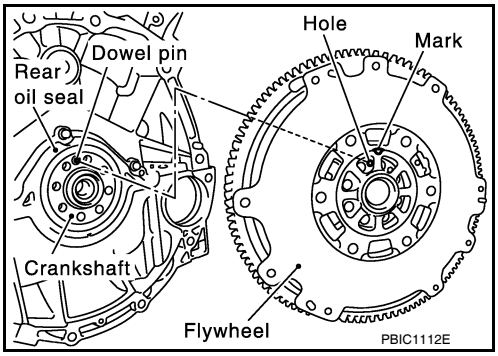
21. Assembly is in the reverse order of disassembly.
22. Remove engine from engine stand.
23. Install flywheel.

- When installing flywheel to crankshaft, be sure to correctly align crankshaft side dowel pin and flywheel side dowel pin hole.

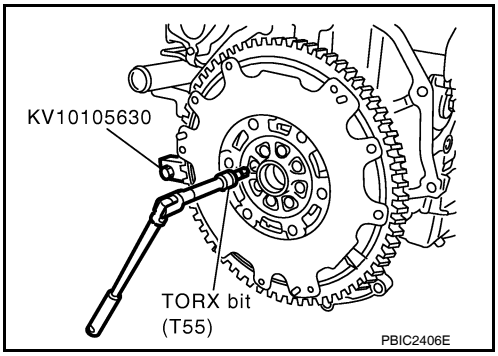
CAUTION:
If these are not aligned correctly, engine runs roughly and "MI" turns on.



- There is a mating mark on the clutch cover side of flywheel.



- Hold ring gear with Tool to tighten flywheel bolts with TORX socket (size: T55).
- Tighten bolts uniformly in a crisscross manner.



- If these are not aligned correctly, engine runs roughly and "MI" turns on.

24. Installation is in the reverse order of removal.

How to Select Piston and Bearing

INFOID:0000000006927547

DESCRIPTION

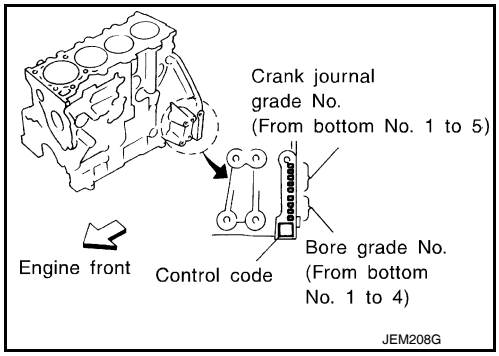
Selection points	Selection parts	Selection items	Selection methods
Between cylinder block to crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft to connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Combining service grades for connecting rod big end diameter and crankshaft pin outer diameter determine connecting rod bearing selection.
Between cylinder block to piston	Piston and piston pin assembly The piston is available together with piston pin as an assembly.	Piston grade (piston outer diameter)	Piston grade = cylinder bore grade (inner diameter of bore)

- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- For details of the measurement method of each part, the reuse standards and the selection method of the selective fitting parts, follow the applicable procedure.

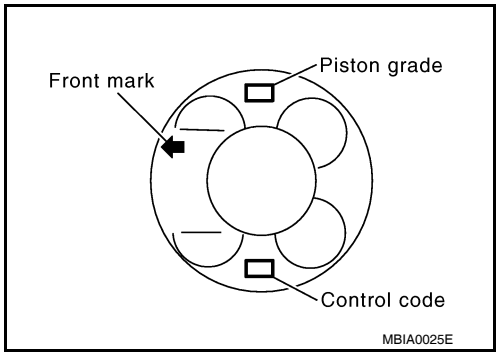
HOW TO SELECT PISTON

When Using New Cylinder Block

1. Identify the cylinder bore grade (No. 1, 2, or 3) on LH surface at the rear of cylinder block.
2. Select piston of the same grade.
   - The part No. of piston is specified together with piston pin as an assembly.



When Re-using an Old Cylinder Block



1. Measure cylinder bore inner diameter. Refer to EM-192, "Inspection After Disassembly".
2. Follow the “Cylinder bore inner diameter” in “Piston Selection Table” determine the bore grade.
3. Select piston of the same grade.

Piston Selection Table

Unit: mm (in)

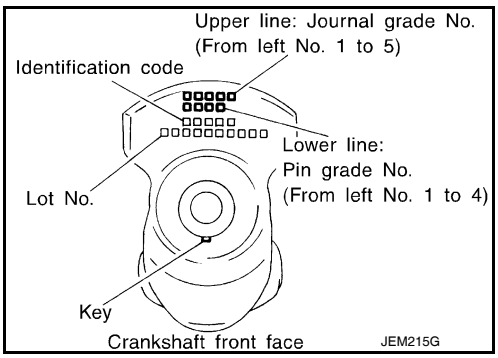
Grade (punched)	1	2	3
Cylinder bore inner diameter	89.000 - 89.010 (3.5039 - 3.5043)	89.010 - 89.020 (3.5043 - 3.5047)	89.020 - 89.030 (3.5047 - 3.5051)
Piston outer diameter	88.928 - 88.942 (3.5011 - 3.5016)	88.938 - 88.952 (3.5015 - 3.5020)	88.948 - 88.962 (3.5019 - 3.5024)

NOTE:
Piston is available together with piston pin as an assembly.

HOW TO SELECT CONNECTING ROD BEARING

When Using New Crankshaft and Connecting Rod

1. Identify the pin diameter grade (No. 0, 1, or 2) on front surface of crankshaft.
2. Select connecting rod bearings of the same grade.
   NOTE:
   There is no grading for the inner diameter of the big end of the connecting rod.



When Re-using the Removed Crankshaft and Connecting Rod

1. Measure the inner diameter of the big end of connecting rod and make sure it is within the specified range. Refer to EM-192, "Inspection After Disassembly".
2. Measure the outer diameter of the crankshaft pin. Refer to EM-192, "Inspection After Disassembly".
3. Determine the crankshaft pin grade by comparing the measurement with the values under the column “Crankshaft pin outer diameter” in “Selection Table of connecting Rod Bearing”.
4. Choose bearings of the same grade.

Selection Table of connecting Rod Bearing

Unit: mm (in)

Connecting rod big end inner diameter	55.000 - 55.013 (2.1654 - 2.1659)

Unit: mm (in)

Crankshaft pin outer diameter	Grade (Mark)	Dimension (Bearing thickness range)	Bearing grade No.	Color
51.968 - 51.974 (2.0460 - 2.0462)	0	1.492 - 1.496 (0.0587 - 0.0589)	STD 0	Black
51.961 - 51.968 (2.0457 - 2.0460)	1	1.496 - 1.500 (0.0589 - 0.0591)	STD 1	Brown
51.954 - 51.961 (2.0454 - 2.0457)	2	1.500 - 1.504 (0.0591 - 0.0592)	STD 2	Green

Undersize Bearing Usage

- If bearing clearance is out of the specifications for connecting rod bearings in standard size, use undersize bearings.
- When using undersize bearings, measure bearing inner diameter with bearing installed, and grind crankshaft pins to adjust clearance to specification.

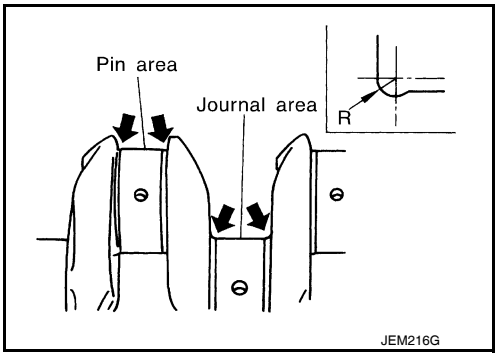
Connecting Rod Bearing Undersize List

Unit: mm (in)

Size	Thickness
US 0.08 (0.0031)	1.536 - 1.540 (0.0605 - 0.0606)
US 0.12 (0.0047)	1.556 - 1.560 (0.0613 - 0.0614)
US 0.25 (0.0098)	1.621 - 1.625 (0.0638 - 0.0640)

CAUTION:
When grinding the crankshaft pin to use an undersize bearing, avoid damaging the fillet R.

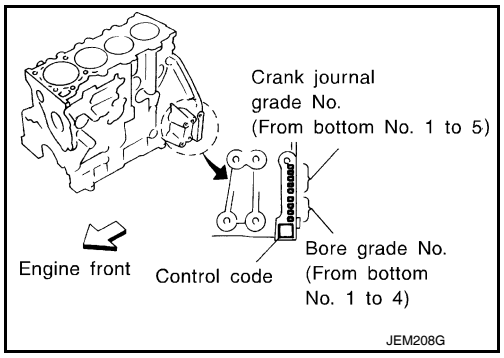
Standard dimension R : 1.5 - 1.7 mm (0.0591 - 0.0669 in)



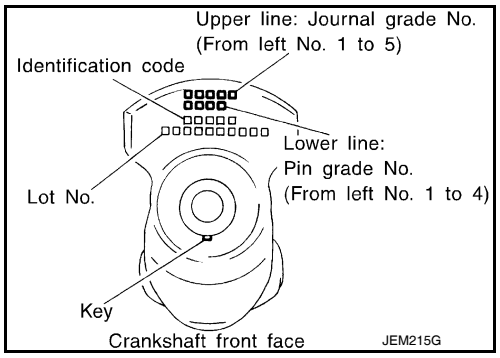
HOW TO SELECT MAIN BEARING

When Using New Cylinder Block and Crankshaft

1. Identify the crank journal grade (No. 0, 1, or 2) on LH surface at the rear of the cylinder block, and locate the applicable grade on the “Grade” row in the “Main Bearing Grade Table”.



2. Identify the journal grade (No. 0, 1, or 2) on the front surface of crankshaft, and locate the applicable grade under the “Grade” column in the “Main Bearing Grade Table”.



3. The main bearing to be used (STD 0 to STD 4) can be located in the cell where the row and column cross.

When Re-using Removed Cylinder Block and Crankshaft

1. Measure the inner diameter of cylinder block main bearing housing. Refer to EM-192, "Inspection After Disassembly".
2. Locate the applicable cell where the measurement falls, on “Inner diameter of Cylinder block main bearing housing” row in the “Main Bearing Grade Table”.
3. Measure the outer diameter of crankshaft journal. Refer to EM-192, "Inspection After Disassembly".
4. Locate the applicable cell where the measurement falls, under “Crankshaft journal outer diameter” column in the “Main Bearing Grade Table”.
5. The main bearing to be used (STD 0 to STD 4) can be located in the cell where the row and column cross.

Main Bearing Grade Table

Unit: mm (in)

Inner diameter of Cylinder block main bearing housing			66.654 - 66.663 (2.6242 - 2.6245)	66.663 - 66.672 (2.6245 - 2.6249)	66.672 - 66.681 (2.6249 - 2.6252)
Crankshaft journal outer diameter	Grade (punched)		0	1	2
62.967 - 62.975 (2.4790 - 2.4793)	0	• Bearing grade No. • Bearing thickness • Oil clearance • Identification color	STD 0 1.816 - 1.820 (0.0715 - 0.0717) 0.039 - 0.066 (0.0015 - 0.0026) Black	STD 1 1.820 - 1.824 (0.0717 - 0.0718) 0.039 - 0.066 (0.0015 - 0.0026) Brown	STD 2 1.824 - 1.828 (0.0718 - 0.0720) 0.039 - 0.066 (0.0015 - 0.0026) Green

62.959 - 62.967 (2.4787 - 2.6790)	1	• Bearing grade No. • Bearing thickness • Oil clearance • Identification color	STD 1 1.820 - 1.824 (0.0717 - 0.0718) 0.039 - 0.066 (0.0015 - 0.0026) Brown	STD 2 1.824 - 1.828 (0.0718 - 0.0720) 0.039 - 0.066 (0.0015 - 0.0026) Green	STD 3 1.828 - 1.832 (0.0720 - 0.0721) 0.039 - 0.066 (0.0015 - 0.0026) Yellow
62.951 - 62.959 (2.4784 - 2.4787)	2	• Bearing grade No. • Bearing thickness • Oil clearance • Identification color	STD 2 1.824 - 1.828 (0.0718 - 0.0720) 0.039 - 0.066 (0.0015 - 0.0026) Green	STD 3 1.828 - 1.832 (0.0720 - 0.0721) 0.039 - 0.066 (0.0015 - 0.0026) Yellow	STD 4 1.832 - 1.836 (0.0721 - 0.0723) 0.039 - 0.066 (0.0015 - 0.0026) Blue

Undersize Bearing Usage

- If bearing clearance is out of the specifications for main bearings in standard size, use undersize bearings.
- When using undersize bearings, measure bearing inner diameter with bearing installed, and grind crankshaft journals to adjust clearance to the specification.

Main Bearing Undersize List

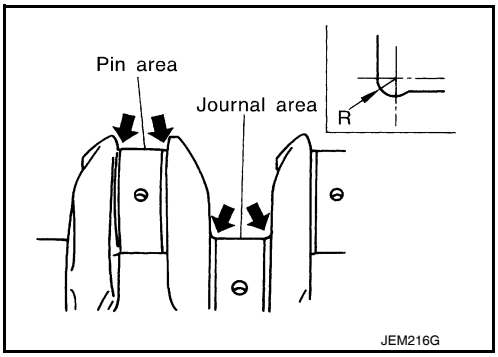
Unit: mm (in)

Size	Thickness
US 0.25(0.0098)	1.949 - 1.953 (0.0767 - 0.0769)

CAUTION:

When grinding crank journals to use undersize bearings, keep corners radius of fillet R. (All journals)

Standard dimension R : 1.5 - 1.7 mm (0.0591 - 0.0669 in)



Inspection After Disassembly

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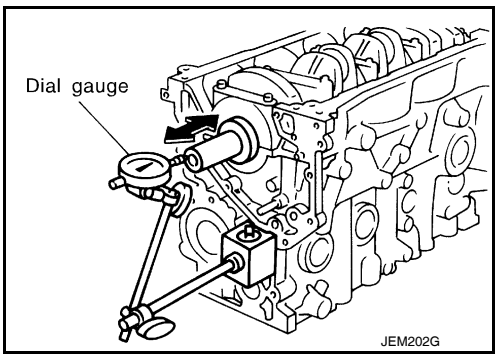
CRANKSHAFT END PLAY

- Using dial gauge, measure crankshaft travel amount by moving the crankshaft forward or backward.

Standard : 0.10 - 0.25 mm (0.0039 - 0.0098 in)

Limit : 0.30 mm (0.0118 in)



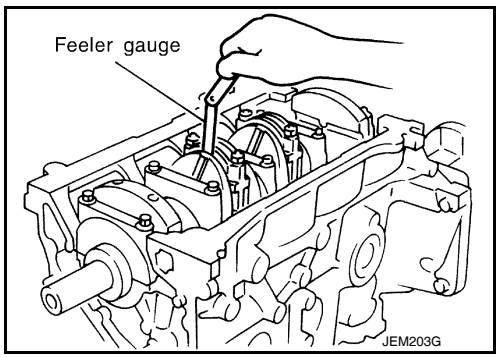
- If the value exceeds the limit, replace thrust bearings with new ones and measure again.
  If the measurement exceeds the limit again, replace crankshaft with a new one.

CONNECTING ROD SIDE CLEARANCE

- Using feeler gauge, measure side clearance between connecting rod and crankshaft arm.

Standard : 0.20 - 0.35 (0.0079 - 0.0138 in)
Limit : 0.40 mm (0.0157 in)

- If measured value exceeds the limit, replace connecting rod and repeat measurement.
  If measured value still exceeds the limit, replace crankshaft.

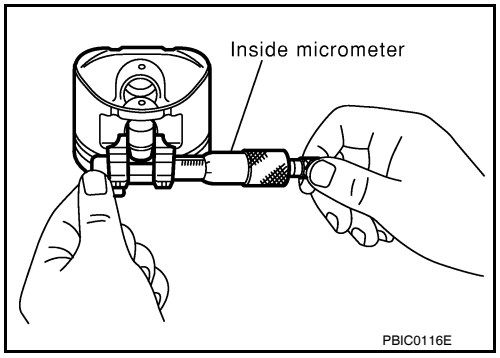


PISTON TO PISTON PIN CLEARANCE

Piston Pin Bore Diameter

Using inside micrometer, measure piston pin bore diameter.

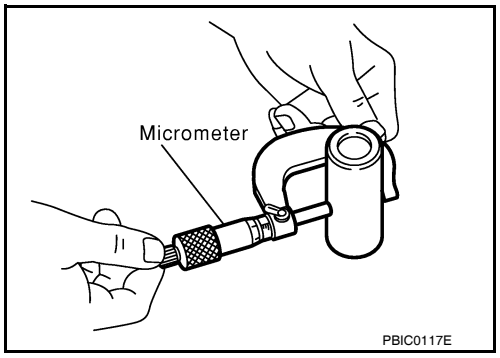
Standard : 28.003 - 28.009 mm (1.1025 - 1.1027 in)



Piston Pin Outer Diameter

Using micrometer, measure piston pin outer diameter.

Standard : 27.995 - 28.000 mm (1.1022 - 1.1024 in)



Calculation of Piston to Piston Pin Clearance

(Piston pin clearance) = (Piston pin bore diameter) – (Piston pin outer diameter)

Standard : 0.003 - 0.014 mm (0.0001 - 0.0006 in)

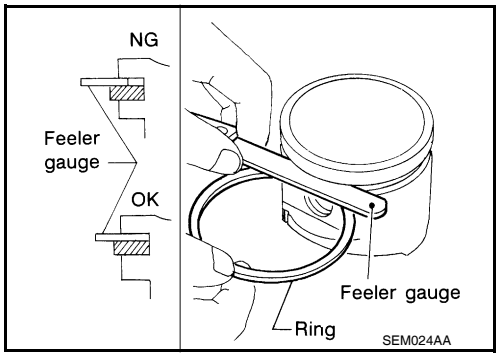
- If out of the standard, replace piston/piston pin assembly.
  NOTE:
  Piston is available together with piston pin as assembly.

PISTON RING SIDE CLEARANCE

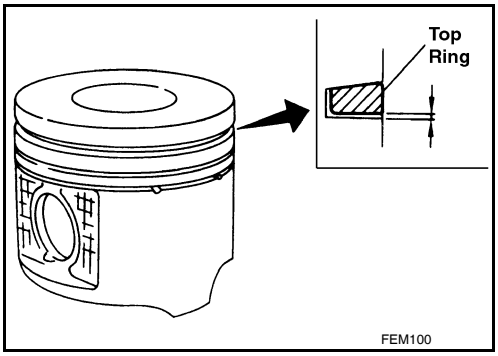
- Using feeler gauge, measure the side clearance between piston ring and piston ring groove.

Unit: mm (in)

Item	Standard	Limit
Top ring	0.050 - 0.090 (0.0020 - 0.0035)	0.2 (0.008)
2nd ring	0.050 - 0.090 (0.0020 - 0.0035)	0.1 (0.004)
Oil ring	0.030 - 0.070 (0.0012 - 0.0028)	—



- Align top ring and external surface of piston. Measure lower side clearance of top ring with top ring pressed onto upper side of ring groove.
- If side clearance exceeds the limit, replace piston ring.
- Check clearance again. If side clearance still exceeds the limit, replace piston.

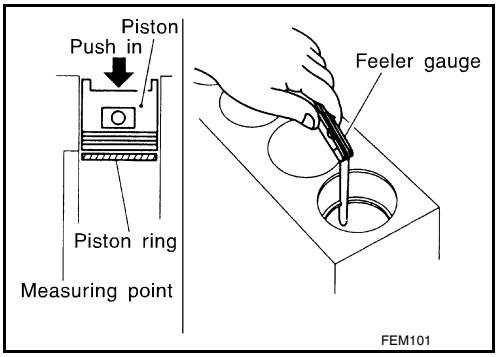


PISTON RING END GAP

- Make sure that cylinder bore diameter is within the specifications.
- Lubricate with new engine oil to piston and piston ring, and then insert piston ring until middle of cylinder with piston, and measure piston ring end gap with feeler gauge.

Unit: mm (in)

Item	Standard	Limit
Top ring	0.21 - 0.28 (0.0083 - 0.0110)	1.0 (0.039)
2nd ring	0.32 - 0.47 (0.0126 - 0.0185)	
Oil ring	0.30 - 0.55 (0.0118 - 0.0217)	



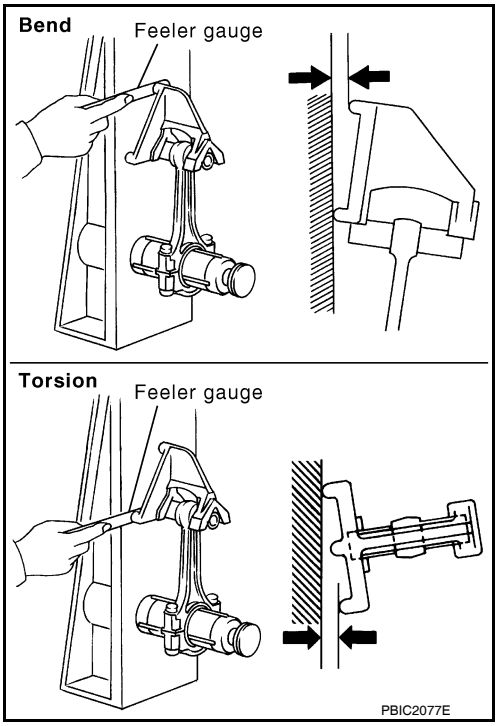
- If out of the limit, replace piston ring.

CONNECTING ROD BEND AND TORSION

- Use connecting rod aligner to check bend and torsion.

Bend limit : 0.12 mm (0.0047 in)/100 mm (3.94 in)
Torsion limit : 0.12 mm (0.0047 in)/100 mm (3.94 in)

- If it exceeds the limit, replace connecting rod assembly.

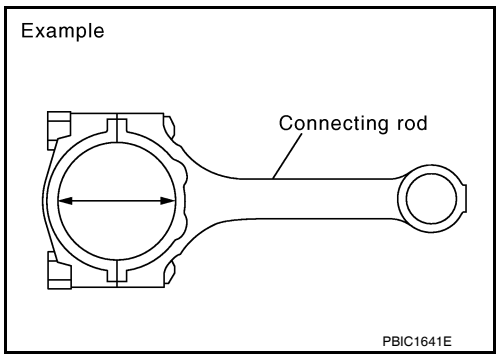


CONNECTING ROD BIG END INNER DIAMETER

- Install connecting rod caps without connecting rod bearings and tighten connecting rod nuts to specification. Refer to EM-180, "Disassembly and Assembly".
- Using inside micrometer, measure connecting rod big end inner diameter.

Standard : 55.000 - 55.013 mm (2.1654 - 2.1659 in)

- If out of the standard, replace connecting rod.

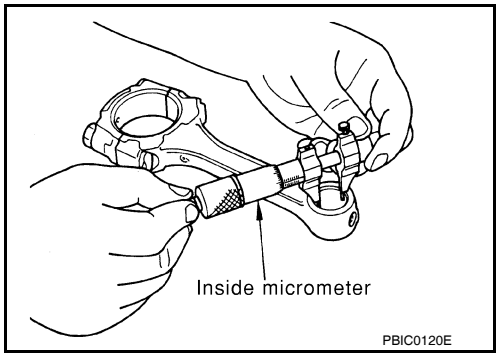


CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

Use inside micrometer to measure bushing inner diameter.

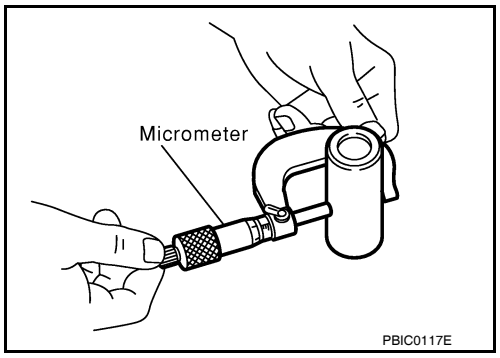
Standard : 28.026 - 28.038 mm (1.1034 - 1.1039 in)



Piston Pin Outer Diameter

Use micrometer to measure piston pin outer diameter.

Standard : 27.995 - 28.000 mm (1.1022 - 1.1024 in)



Calculation of Connecting Rod Bushing Clearance

(Connecting rod bushing clearance) = (Connecting rod bushing inner diameter) – (Piston pin outer diameter)

Standard : 0.026 - 0.043 mm (0.0010 - 0.0017 in)

Limit : 0.057 mm (0.0022 in)

- If it exceeds the limit, replace connecting rod and/or piston and piston pin assembly. Refer to EM-188, "How to Select Piston and Bearing".

CYLINDER BLOCK TOP SURFACE DISTORTION

- Using scraper, remove gasket installed onto cylinder block surface. Remove contamination such as engine oil, scale, and carbon.

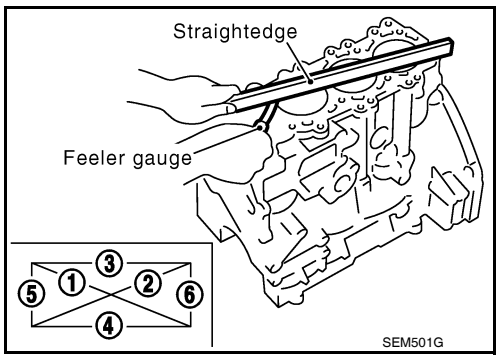
CAUTION:

Keep broken pieces of gasket clear of engine oil and engine coolant passages.

- Use straightedge and feeler gauge to check block upper surface in six locations for distortion as shown.

Limit : 0.1 mm (0.004 in)

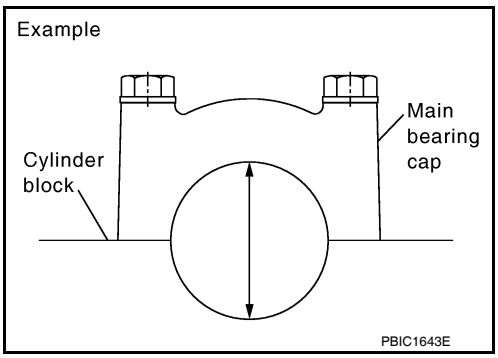
- If it exceeds the limit, replace cylinder block.



MAIN BEARING HOUSING INNER DIAMETER

- Without installing main bearings, install main bearing caps, and tighten bolts to the specified torque. Refer to EM-180, "Disassembly and Assembly".
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : 66.654 - 66.681 mm (2.6242 - 2.6252 in)



- If the measurement is out of the standard, replace cylinder block and main bearing caps.

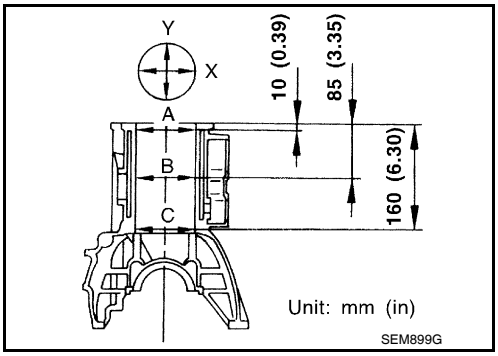
NOTE:
These components cannot be replaced as a single unit, because they were processed together.

PISTON TO CYLINDER BORE CLEARANCE

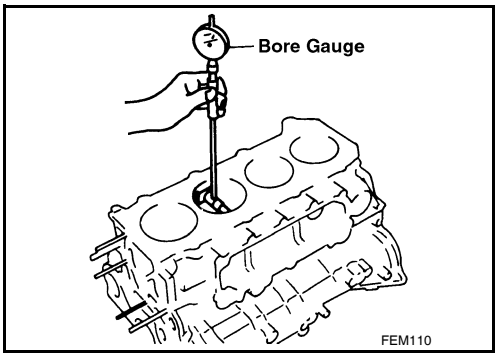
Cylinder Bore Inner Diameter

- Using bore gauge, measure cylinder inner diameters at six positions; top, middle, and bottom (A, B, C) in 2 directions (X, Y).

Cylinder bore inner diameter
: 89.000 – 89.030 mm (3.5039 – 3.5051 in)
Wear limit
: 0.07 mm (0.0028 in)
Out-of-round limit (Difference between X and Y)
: 0.015 mm (0.0006 in)
Taper limit (Difference between A and C)
: 0.010 mm (0.0004 in)



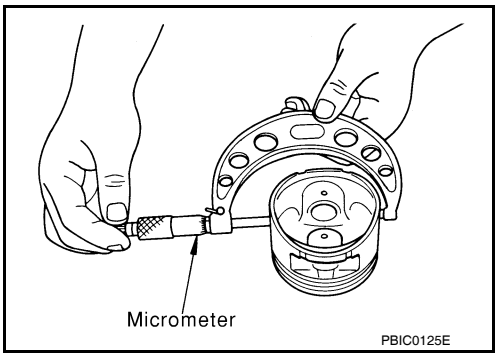
- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, hone or bore the inner wall.



Piston Outer Diameter

Use micrometer to measure piston outer diameter.

Piston outer diameter
Measurement position : 11.0 mm (0.43 in) Distance from the bottom
Standard : 88.928 – 88.962 mm (3.5011 – 3.5024 in)



Calculation of Piston to Cylinder Bore Clearance

- Calculate using piston outer diameter and cylinder bore inner diameter (direction X, position B).
  (Clearance) = (Cylinder bore inner diameter) − (Piston outer diameter)

Specifications at room temperature [20°C (68°F)]:

Standard : 0.058 - 0.082 mm (0.0023 - 0.0032 in)

- If it exceeds the limit, replace piston and piston pin assembly. Refer to EM-188, "How to Select Piston and Bearing".

Reboring Cylinder Bore

1. Determine the cylinder bore size by adding piston-to-cylinder bore clearance to piston diameter.

Rebore size calculation:

D = A + B – C

Where,

D: Bored diameter

A: Piston outer diameter as measured

B: Piston-to-cylinder bore clearance

C: Honing allowance 0.02 mm (0.0008 in)

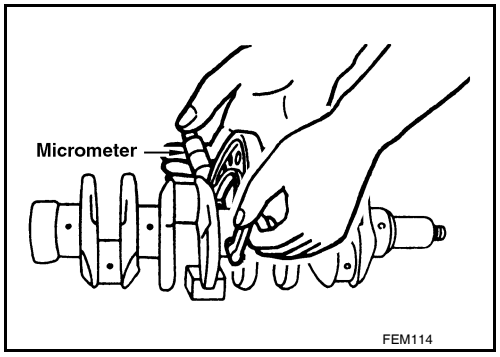
2. Install main bearing caps and tighten bolts to specification. Refer to EM-180, "Disassembly and Assembly". This will prevent distortion of cylinder bores.
3. Cut cylinder bore.
   NOTE:
   - When any cylinder needs boring, all other cylinders must also be bored.
   - Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so at a time.
4. Hone cylinders to obtain the specified piston-to-cylinder bore clearance.
5. Measure finished cylinder bore for the out-of-round and taper.
   NOTE:
   - Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

- Use micrometer to measure crankshaft main journal diameter.

Standard : 62.951 - 62.975 mm (2.4784 - 2.4793 in)

- If out of the standard, measure the main bearing oil clearance. then use the undersize bearing.

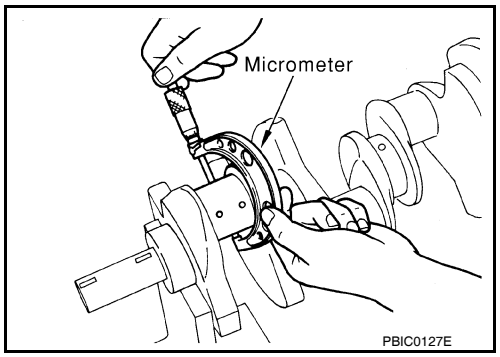


CRANKSHAFT PIN JOURNAL DIAMETER

- Use micrometer to measure crankshaft pin journal diameter.

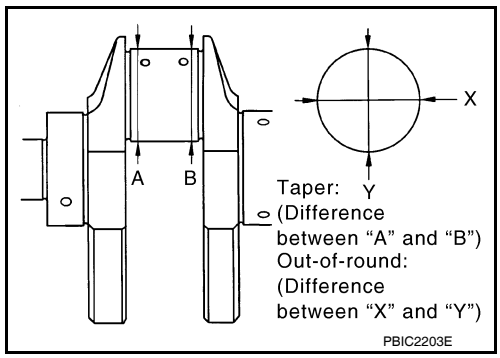
Standard : 51.954 - 51.974 mm (2.0454 - 2.0462 in)

- If out of the standard, measure the connecting rod bearing oil clearance. then use the undersize bearing.



CRANKSHAFT OUT-OF-ROUND AND TAPER

- Using micrometer, measure each journal and pin at four points as shown.
- Out-of-round value is indicated by difference in dimensions between directions X and Y at points A and B.
- Taper value is indicated by difference in dimensions between points A and B in directions X and Y.

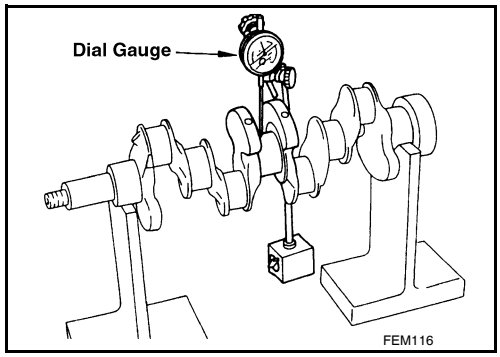


Out-of-round: (Difference between X and Y)
Standard : 0.003 mm (0.0001 in)
Limit : 0.005 mm (0.0002 in)
Taper: (Difference between A and B)
Standard : 0.003 mm (0.0001 in)
Limit : 0.005 mm (0.0002 in)

- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected journal and/or pin. Then select the main bearing or connecting rod bearing.

CRANKSHAFT RUNOUT

- Place V-block onto surface plate to support journals at both ends of crankshaft.
- Position dial gauge vertically onto No. 3 journal.
- Rotate crankshaft to read needle movement on dial gauge. (Total indicator reading)



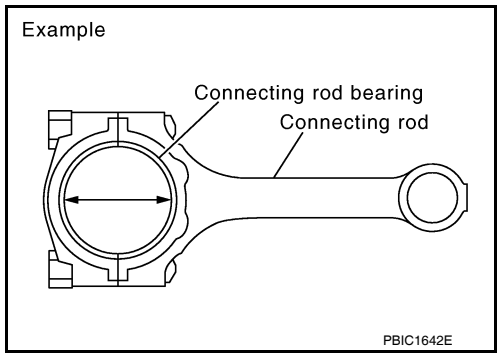
Standard : 0.05 mm (0.0020 in)
Limit : 0.10 mm (0.0039 in)

- If it exceeds the limit, replace crankshaft.

CONNECTING ROD BEARING OIL CLEARANCE

Method by Measurement

- Install connecting rod bearings to connecting rod and cap, and tighten connecting nuts to specification. Refer to EM-180, "Disassembly and Assembly". Use inside micrometer to measure connecting rod bearing inner diameter.
  (Bearing clearance) = (Connecting rod bearing inner diameter) – (Crankshaft pin outer diameter)

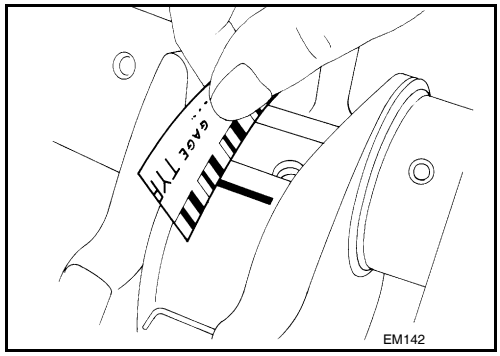


Standard : 0.039 - 0.070 mm (0.0015 - 0.0028 in)

- If clearance exceeds the standard, select proper connecting rod bearing according to connecting rod big end diameter and crankshaft pin outer diameter to obtain specified bearing oil clearance. Refer to EM-188, "How to Select Piston and Bearing".

Method of Using Plastigage

- Remove contamination such as engine oil, dust completely from crankshaft pins and each bearing surface.
- Cut plastigage slightly shorter than bearing width, place it in crankshaft direction, avoiding oil holes.
- Install connecting rod bearings to caps, and tighten connecting rod nuts to specification.
  CAUTION:
  Do not rotate crankshaft.
- Remove connecting rod caps and bearings, and measure plastigage width using scale on plastigage bag.
  NOTE:



If out of specification, take same action mentioned in “Method by Measurement”.

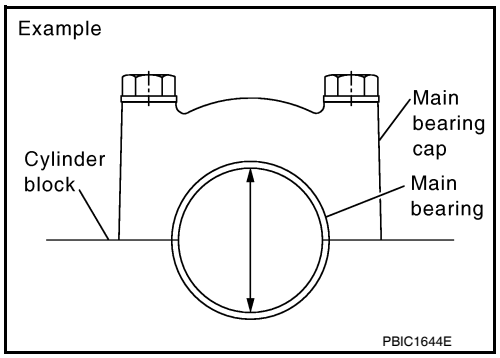
MAIN BEARING OIL CLEARANCE

Method by Measurement

- Install main bearings to cylinder block and bearing cap, and tighten the bolts to specification. Refer to EM-180, "Disassembly and Assembly". Then, measure the inner diameter of main bearings.
  (Bearing clearance) = (Bearing inner diameter) – (Crankshaft journal outer diameter)

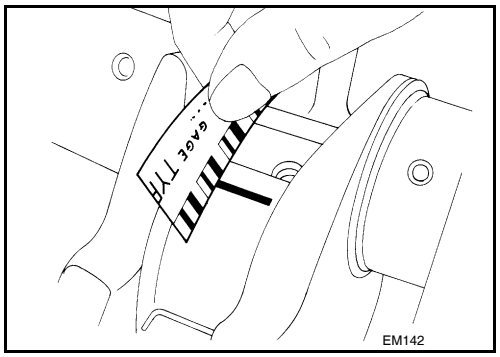
Standard : 0.047 - 0.077 mm (0.0019 - 0.0030 in)

- If out of the standard, check main bearing housing inner diameter and crankshaft journal outer diameter, and select appropriate main bearing to adjust clearance to specifications. Refer to EM-188, "How to Select Piston and Bearing".



Method of Using Plastigage

- Remove contamination such as engine oil and dust completely from crankshaft journals and each bearing surface.
- Cut plastigage slightly shorter than bearing width. Place it in crankshaft turning direction, avoiding oil holes.
- Install main bearings and bearing cap and tighten to specification. Refer to EM-180, "Disassembly and Assembly" for the tightening procedure.
  CAUTION:
  Do not rotate crankshaft.
- Remove main bearings and bearing caps, and measure plastigage width using scale on plastigage bag.
  NOTE:
  If out of specification, take same action mentioned in “Method by Measurement”.

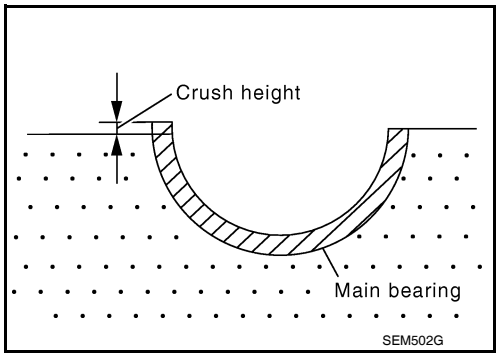


CRUSH HEIGHT OF MAIN BEARING

- When bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude. Refer to EM-180, "Disassembly and Assembly".

Standard : There must be crush height.

- If out of the standard, replace main bearings.

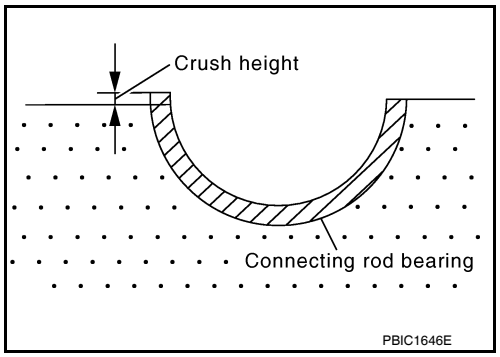


CRUSH HEIGHT OF CONNECTING ROD BEARING

- When connecting rod bearing cap is removed after being tightened to specification with connecting rod bearings installed, the tip end of bearing must protrude. Refer to EM-180, "Disassembly and Assembly".

Standard : There must be crush height.

- If out of the standard, replace connecting rod bearings.

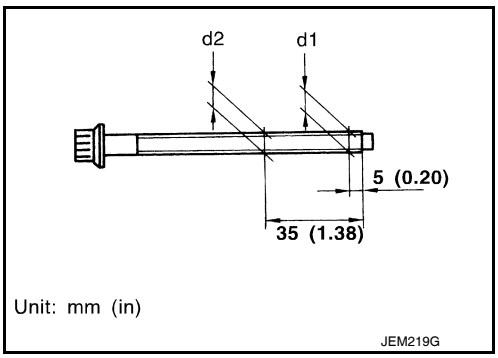


MAIN BEARING CAP BOLT DEFORMATION

- Measure the outer diameter of threaded area, d1 and d2, at the points shown.
- When the necked point is identified at a point other than where specified, measure at the point as d2.
- Calculate the difference between d1 and d2.

Limit : 0.13 mm (0.0051 in)

- If it exceeds the limit, replace main bearing cap bolt.

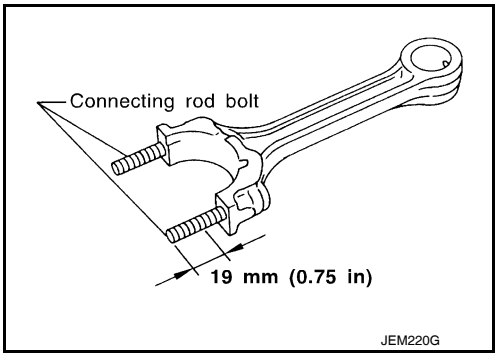


CONNECTING ROD BOLT DEFORMATION

- Install nuts to connecting rod bolts. Make sure that the nut can be screwed smoothly on bolt threads by hand to the last thread on the bolt.
- If the nut does not screw in smoothly, measure the outer diameter of the bolt thread at the point shown.
- If a necked point is identified, measure at that point.

Standard : 8.90 - 9.00 mm (0.3504 - 0.3543 in) dia.
Limit : 8.75 mm (0. 3445 in) dia.

- If it exceeds the limit, replace connecting rod bolts and nuts.

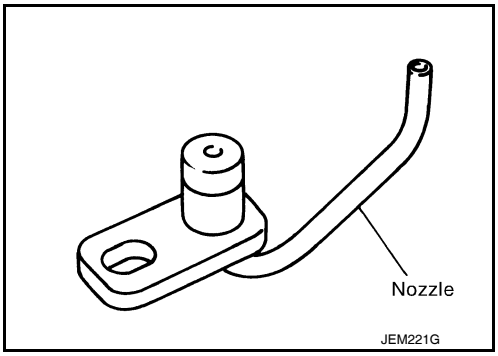


OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.

Standard : No deformation and no damage.

- If out of the standard, replace oil jet.

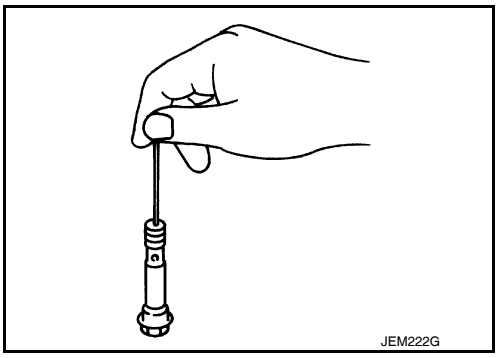


OIL JET RELIEF VALVE

- Using clean plastic stick, press check valve in oil jet relief valve. Make sure that valve moves smoothly with proper reaction force.

Standard:
Valve moves smoothly with proper reaction force.

- If out of the standard, replace oil jet relief valve.



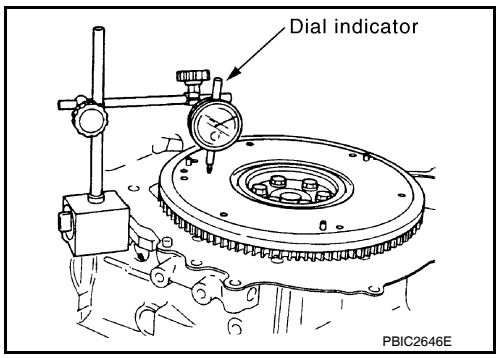
FLYWHEEL DEFLECTION

- Measure the deflection of flywheel contact surface to clutch with a dial indicator.
- Measure the deflection at 210 mm (8.27 in) dia.

Standard : 0.45 mm (0.0177 in) or less.

- If measured value is out of the standard, replace flywheel.

CAUTION:
When measuring, keep magnetic fields (such as dial indicator stand) away from signal plate of the rear end of crankshaft.



MOVEMENT AMOUNT OF FLYWHEEL

CAUTION:
Do not disassemble double mass flywheel.

Movement Amount of Thrust (Fore-and-Aft) Direction

- Measure the movement amount of thrust (fore-and-aft) direction when 100 N (10.2 kg, 22 lb) force is added at the portion of 125 mm (4.92 in) radius from the center of flywheel.

Standard : 1.3 mm (0.051 in) or less

- If measured value is out of the standard, replace flywheel.

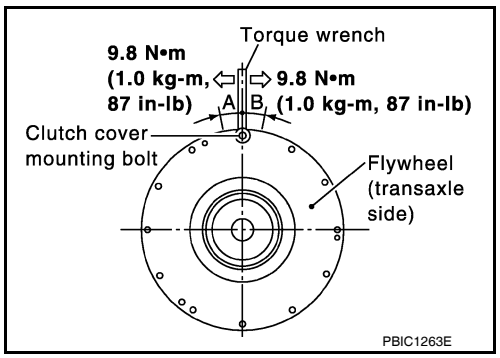
Movement Amount in Radial (Rotation) Direction

Check the movement amount of radial (rotation) direction with the following procedure:

1. Install a bolt to clutch cover mounting hole, and place a torque wrench on the extended line of the flywheel center line.
   - Tighten bolt at a force of 9.8 N·m (1.0 kg-m, 87 in-lb) to keep it from loosening.
2. Put a mating mark on circumferences of the two flywheel masses without applying any load (Measurement standard points).
3. Apply a force of 9.8 N·m (1.0 kg-m, 87 in-lb) in each direction, and mark the movement amount on the mass on the transmission side.
4. Measure the dimensions of movement amounts “A” and “B” on circumference of the flywheel on the transmission side.

Standard: 32.0 mm (1.620 in) or less.

- If measured value is out of the standard, replace flywheel.

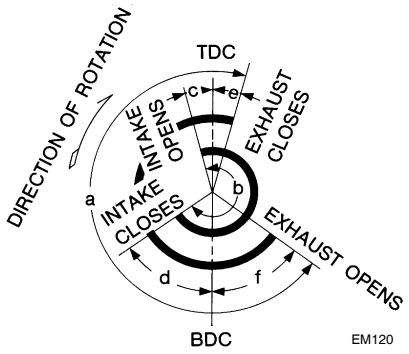


SERVICE DATA AND SPECIFICATIONS (SDS)

Standard and Limit

INFOID:0000000006927549

GENERAL SPECIFICATIONS

Cylinder arrangement		In-line 4
Displacement	Unit: cm^3 (cu in)	2,488 (151.82)
Bore and stroke	Unit: mm (in)	89.0 x 100 (3.504 x 3.937)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		16.5
Compression pressure Unit: kPa (bar, kg/cm^2, psi)/200 rpm	Standard	3,100 (31, 31.6, 450)
	Minimum	2,500 (25, 25.5, 363)
	Differential limit between cylinders	490 (4.9, 5.0, 71)
Valve timing		

Unit: degree

a	b	c	d	e	f
224	212	2	30	-2	46

INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

Item		Limit
Surface distortion	Intake manifold	0.1 (0.004)
	Exhaust manifold	0.3 (0.012)

DRIVE BELTS

Belt Deflection:

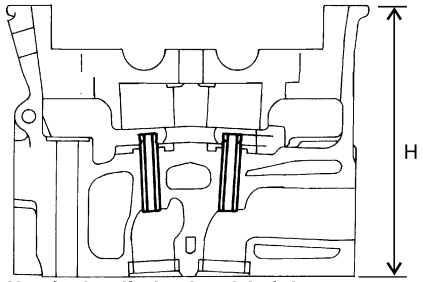
Applied belt	Belt deflection with 98 N (10 kg, 22 lb) force applied* mm (in)		
	New	Adjusted	Limit for re-adjusting
A/C compressor belt	7.0 - 8.0 (0.276 - 0.315)	9.5 - 10.5 (0.374 - 0.413)	12.0 (0.472)
Generator and water pump belt	6.5 - 7.5 (0.256 - 0.295)	8.0 - 9.5 (0.315 - 0.374)	12.5 (0.492)
Power steering pump belt	6.5 - 7.5 (0.256 - 0.295)	8.0 - 10.0 (0.315 - 0.394)	11.5 (0.453)

*: When engine is cold.

CYLINDER HEAD

Unit: mm (in)

Item	Standard	Limit
Cylinder head distortion	Less than 0.04 (0.0016)	0.1 (0.004)



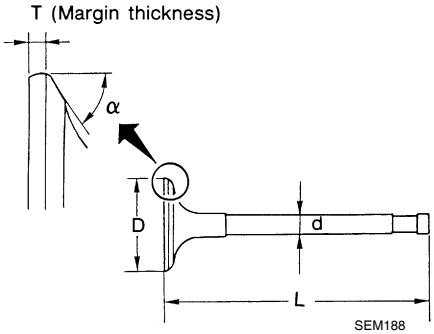
Nominal cylinder head height:
H = 153.9 - 154.1 mm (6.059 - 6.067 in)

JEM204G

VALVE

Valve Dimensions

Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	28.0 - 28.3 (1.102 - 1.114)
	Exhaust	26.0 - 26.3 (1.024 - 1.035)
Valve length “L”	Intake	106.72 (4.2016)
	Exhaust	106.36 (4.1874)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle “α”	Intake and exhaust	45 degrees 15′ - 45 degrees 45′
Valve margin “T”	Intake	1.60 (0.0630)
	Exhaust	1.48 (0.0583)
Valve margin “T” limit		More than 1.0 (0.039)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

Valve Clearance

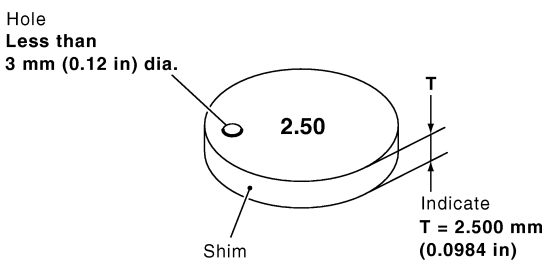
Unit: mm (in)

Item	Cold	Hot* (Reference data)
Intake	0.24 - 0.32 (0.0094 - 0.0126)	0.274 - 0.386 (0.0108 - 0.0152)
Exhaust	0.26 - 0.34 (0.0102 - 0.0134)	0.308 - 0.432 (0.0121 - 0.0170)

*: Approximately 80°C (176°F)

Available Shims

Stamped mark*	Thickness mm (in)
2.10	2.10 (0.0827)
2.12	2.12 (0.0835)
2.14	2.14 (0.0843)
2.16	2.16 (0.0850)
2.18	2.18 (0.0858)
2.20	2.20 (0.0866)
2.22	2.22 (0.0874)
2.24	2.24 (0.0882)
2.26	2.26 (0.0890)
2.28	2.28 (0.0898)
2.30	2.30 (0.0906)
2.32	2.32 (0.0913)
2.34	2.34 (0.0921)
2.36	2.36 (0.0929)
2.38	2.38 (0.0937)
2.40	2.40 (0.0954)
2.42	2.42 (0.0953)
2.44	2.44 (0.0961)
2.46	2.46 (0.0969)
2.48	2.48 (0.0976)
2.50	2.50 (0.0984)
2.52	2.52 (0.0992)
2.54	2.54 (0.1000)
2.56	2.56 (0.1008)
2.58	2.58 (0.1016)
2.60	2.60 (0.1024)
2.62	2.62 (0.1031)
2.64	2.64 (0.1039)
2.66	2.66 (0.1047)
2.68	2.68 (0.1055)
2.70	2.70 (0.1063)
2.72	2.72 (0.1071)
2.74	2.74 (0.1079)



SEM512G

*: Always check with the Parts Department for the latest parts information

Valve Spring

Valve spring square	mm (in)	1.9 (0.075)
Free height	mm (in)	44.74 (1.761)
Pressure	N (kg, lb) at height mm (in)	184 - 208 (18.77 - 21.22, 41.4 - 46.8) at 32.82 (1.2921)
Height during valve open	mm (in)	24.82 (0.9772)
Load with valve open	N (kg, lb)	320 - 360 (32.65 - 36.73, 71.9 - 80.9)

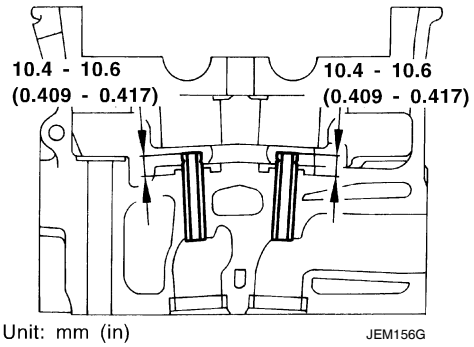
Valve Lifter

Unit: mm (in)

Item	Standard
Valve lifter outer diameter	29.960 - 29.975 (1.1795 - 1.1801)
Valve lifter bore diameter	30.000 - 30.021 (1.1811 - 1.1819)
Valve lifter clearance	0.025 - 0.061 (0.0010 - 0.0024)

Valve Guide

Unit: mm (in)

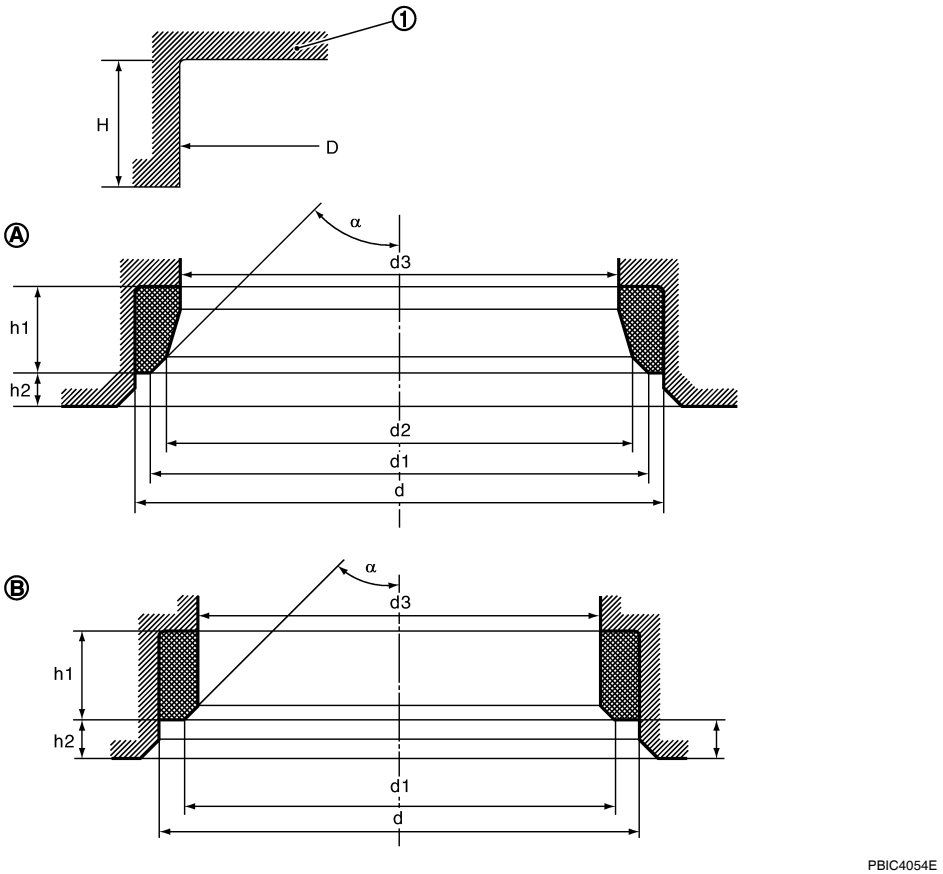


Unit: mm (in) JEM156G

Item		Standard	Service
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Item		Standard	Limit
Valve guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.10 (0.0039)
Projection length		10.4 - 10.6 (0.409 - 0.417)	

Valve Seat

Unit: mm (in)



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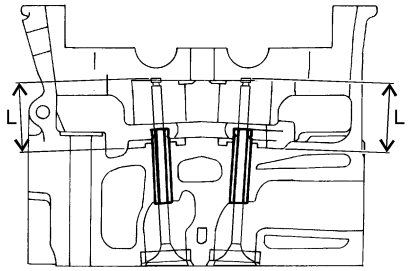


JEM253G

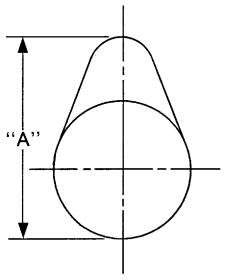
Items		Standard	Oversize [0.5 (0.02)] (Service)
Cylinder head seat (1) recess diameter “D”	Intake	30.000 - 30.016 (1.1811 - 1.1817)	30.500 - 30.516 (1.2008 - 1.2014)
	Exhaust	29.000 - 29.016 (1.1417 - 1.1424)	29.500 - 29.516 (1.1614 - 1.1620)
Valve seat outer diameter “d”	Intake (A)	30.080 - 30.100 (1.1842 - 1.1850)	30.580 - 30.600 (1.2039 - 1.2047)
	Exhaust (B)	29.080 - 29.096 (1.1449 - 1.1455)	29.580 - 29.596 (1.1646 - 1.1652)
Valve seat interference fit	Intake (A)	0.064 - 0.100 (0.0025 - 0.0039)	
	Exhaust (B)	0.064 - 0.096 (0.0025 - 0.0038)	
Diameter “d1”	Intake (A)	27.15 - 27.65 (1.0689 - 1.0886)	26.05 - 26.55 (1.0256 - 1.0453)
	Exhaust (B)	24.95 - 25.45 (0.982 - 1.0020)	24.15 - 24.65 (0.9508 - 0.9705)
Diameter “d2”	Intake (A)	26.00 - 26.50 (1.0236 - 1.0433)	—
	Exhaust (B)	—	
Diameter “d3”	Intake (A)	25.3 - 25.7(0.996 - 1.012)	
	Exhaust (B)	23.3 - 23.7 (0.917 - 0.933)	

Angle “α”		43°30′ - 46°30′	
Height “h1”	Intake (A)	7.0 - 7.1 (0.276 - 0.280)	6.6 - 6.7 (0.260 - 0.264)
	Exhaust (B)	6.7 - 6.8 (0.264 - 0.268)	6.3 - 6.4 (0.248 - 0.252)
Height “h2”	Intake (A)	2.23 - 2.43 (0.0878 - 0.0957)	2.13 - 2.53 (0.0839 - 0.0996)
	Exhaust (B)	2.76 - 2.96 (0.1087 - 0.1165)	2.66 - 3.06 (0.1047 - 0.1205)
Depth “H”	Intake	8.83 - 9.13 (0.3476 - 0.3594)	
	Exhaust	9.06 - 9.36 (0.3567 - 0.3685)	
Projection (L)	Intake	36.53 - 36.98 (1.4382 - 1.4559)	
	Exhaust	36.53 - 37.01 (1.4382 - 1.4571)	

CAMSHAFT

Unit: mm (in)

Item		Standard	Limit
Camshaft journal oil clearance		0.045 - 0.086 (0.0018 - 0.0034)	—
Camshaft bracket inner diameter	No.1	30.500 - 30.521 (1.2008 - 1.2016)	
	No. 2, 3, 4, 5	24.000 - 24.021 (0.9449 - 0.9457)	
Camshaft journal outer diameter	No. 1	30.435 - 30.455 (1.1982 - 1.1990)	
	No. 2, 3, 4, 5	23.935 - 23.955 (0.9423 - 0.9431)	
Camshaft runout [TIR*]		—	0.02 (0.0008)
Camshaft sprocket runout [TIR*]		—	0.15 (0.0059)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.24 (0.0094)



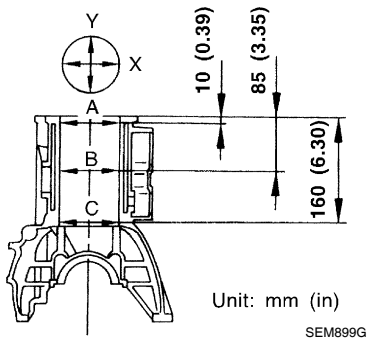
SEM671

Cam height “A”	Intake	39.505 - 39.695 (1.5553 - 1.5628)
	Exhaust	39.905 - 40.095 (1.5711 - 1.5785)

*: Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



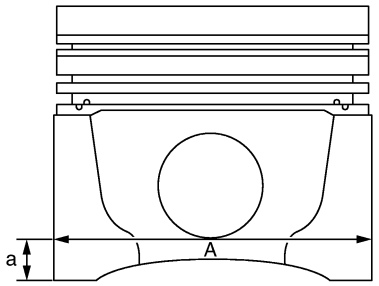
SEM899G

Top surface distortion		Standard		Less than 0.03 (0.0012)
		Limit		0.1 (0.004)
Cylinder bore	Inner diameter	Standard	Grade No. 1	89.000 - 89.010 (3.5039 - 3.5043)
			Grade No. 2	89.010 - 89.020 (3.5043 - 3.5047)
			Grade No. 3	89.020 - 89.030 (3.5047 - 3.5051)
		Wear limit		0.07 (0.0028)
Out-of-round (Difference between X and Y)		Limit		0.015 (0.0006)
Taper (Difference between A and C)				0.010 (0.0004)
Main bearing housing inner diameter (Without bearing)				66.654 - 66.681 (2.6242 - 2.6252)
Difference in inner diameter between cylinders	Limit			Less than 0.05 (0.0020)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



MBIA0026E

		Grade*	Dimension
Piston outer diameter “A”	Standard	Grade No. 1	88.928 - 88.942 (3.5011 - 3.5016)
		Grade No. 2	88.938 - 88.952 (3.5015 - 3.5020)
		Grade No. 3	88.948 - 88.962 (3.5019 - 3.5024)
“a” dimension			11.0 (0.43)
Piston pin bore diameter			28.003 - 28.009 (1.1025 - 1.1027)
Piston to cylinder bore clearance			0.058 - 0.082 (0.0023 - 0.0032)

*: Always check with the Parts Department for the latest parts information

Piston Ring

Unit: mm (in)

Item		Standard	Limit
Side clearance	Top	0.050 - 0.090 (0.0020 - 0.0035)	0.2 (0.008)
	2nd	0.050 - 0.090 (0.0020 - 0.0035)	0.1 (0.004)
	Oil ring	0.030 - 0.070 (0.0012 - 0.0028)	—
End gap	Top	0.21 - 0.28 (0.0083 - 0.0110)	1.0 (0.039)
	2nd	0.32 - 0.47 (0.0126 - 0.0185)	
	Oil ring	0.30 - 0.55 (0.0118 - 0.0217)	

Piston Pin

Unit: mm (in)

Piston pin outer diameter	27.995 - 28.000 (1.1022 - 1.1024)
Piston to piston pin clearance	0.003 - 0.014 (0.0001 - 0.0006)

Connecting rod bushing clearance	Standard	0.026 - 0.043 (0.0010 - 0.0017)
	Limit	0.057 (0.0022)

CONNECTING ROD

Unit: mm (in)

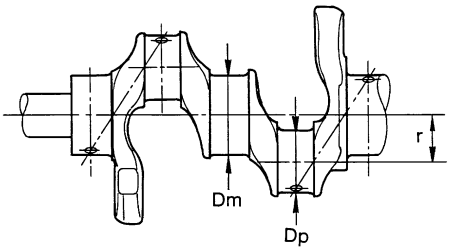
Center distance		154.5 (6.083)
Bend [per 100 (3.94)]	Limit	0.12 (0.0047)
Torsion [per 100 (3.94)]	Limit	0.12 (0.0047)
Connecting rod bushing inner diameter*		28.026 - 28.038 (1.1034 - 1.1039)
Connecting rod big end inner diameter*		55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.40 (0.0157)

*: After installing in connecting rod

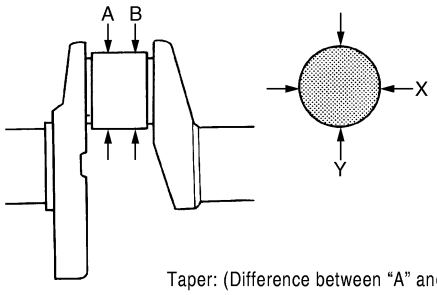
CRANKSHAFT

Unit: mm (in)

Main journal dia. “Dm”		62.951 - 62.975 (2.4784 - 2.4793)
Pin journal dia. “Dp”		51.954 - 51.974 (2.0454 - 2.0462)
Center distance “r”		49.97 - 50.03 (1.9673 - 1.9697)
Out-of-round (Difference between X and Y)	Standard	0.003 (0.0001)
	Limit	0.005 (0.0002)
Taper (Difference between A and B)	Standard	0.003 (0.0001)
	Limit	0.005 (0.0002)
Runout [TIR*]	Standard	0.05 (0.0020)
	Limit	0.10 (0.0039)
End play	Standard	0.10 - 0.25 (0.0039 - 0.0098)
	Limit	0.30 (0.0118)



SEM645



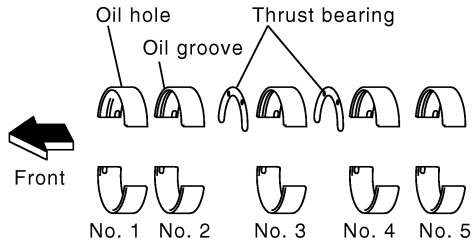
Taper: (Difference between “A” and “B”)
Out-of-round: (Difference between “X” and “Y”)
SBIA0535E

*: Total indicator reading

AVAILABLE MAIN BEARING

Main bearing

Unit: mm (in)



SEM255G

Grade number*	Thickness "T"	Width "W"	Identification color
STD 0	1.816 - 1.820 (0.0715 - 0.0717)	19.9 - 20.1 (0.783 - 0.791)	Black
STD 1	1.820 - 1.824 (0.0717 - 0.0718)		Brown
STD 2	1.824 - 1.828 (0.0718 - 0.0720)		Green
STD 3	1.828 - 1.832 (0.0720 - 0.0721)		Yellow
STD 4	1.832 - 1.836 (0.0721 - 0.0723)		Blue

*: Always check with the Parts Department for the latest parts information

Undersize

Unit: mm (in)

Size	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.949 - 1.953 (0.0767 - 0.0769)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Connecting Rod Bearing

Unit: mm (in)

Grade number*	Thickness "T"	Width "W"	Identification color (mark)
STD 0	1.492 - 1.496 (0.0587 - 0.0589)	22.9 - 23.1 (0.902 - 0.909)	Black
STD 1	1.496 - 1.500 (0.0589 - 0.0591)		Brown
STD 2	1.500 - 1.504 (0.0591 - 0.0592)		Green

*: Always check with the Parts Department for the latest parts information

Undersize

Unit: mm (in)

Size	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.536 - 1.540 (0.0605 - 0.0606)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.556 - 1.560 (0.0613 - 0.0614)	
0.25 (0.0098)	1.621 - 1.625 (0.0638 - 0.0640)	

MISCELLANEOUS COMPONENTS

Flywheel

Unit: mm (in)

Flywheel deflection [TIR]* [At 210 (8.27) dia.]	Standard	0.45 (0.0177) or less
Radial movement amount	Standard	1.3 (0.051) or less
Thrust movement amount	Standard	32.0 (1.620) or less

*: Total indicator reading

Bearing Clearance

Unit: mm (in)

Main bearing oil clearance	Standard	0.047 - 0.077 (0.0019 - 0.0030)
Connecting rod bearing oil clearance	Standard	0.039 - 0.070 (0.0015 - 0.0028)